Breast Ultrasound

Imaging Technique
Sonographic Breast Anatomy

Grateful appreciation to Richard A. Lopchinsky, MD, FACS and Nancy H. Van Name, RDMS, RTR, and Marlene Kattaron, RDMS

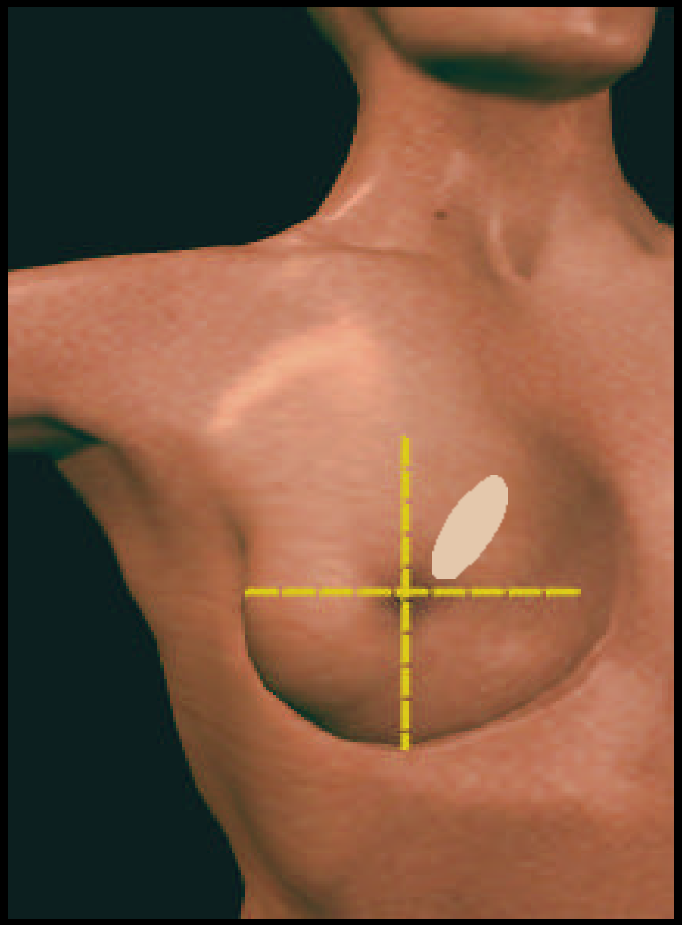
Technique: Examiner Position

- Physical comfort
  - Personal preference
- Initial examination
  - Machine to patient's right
  - Image with right hand
  - Operate machine with left hand
- Interventional examination
  - Position machine on opposite side of patient to be examined

Technique: **Patient Position**

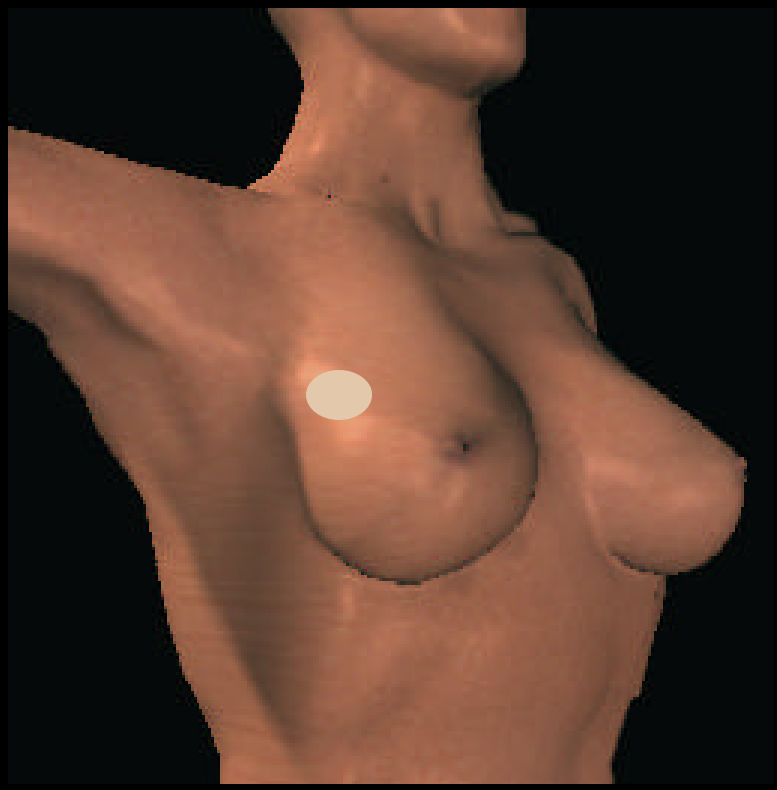
- Maximize tissue thinness
- Reduce reflective and refractive attenuation
- Maintain ultrasound transducer parallel to breast surface
- Maintain ultrasound beam perpendicular to breast tissue

Technique: **Patient Position**



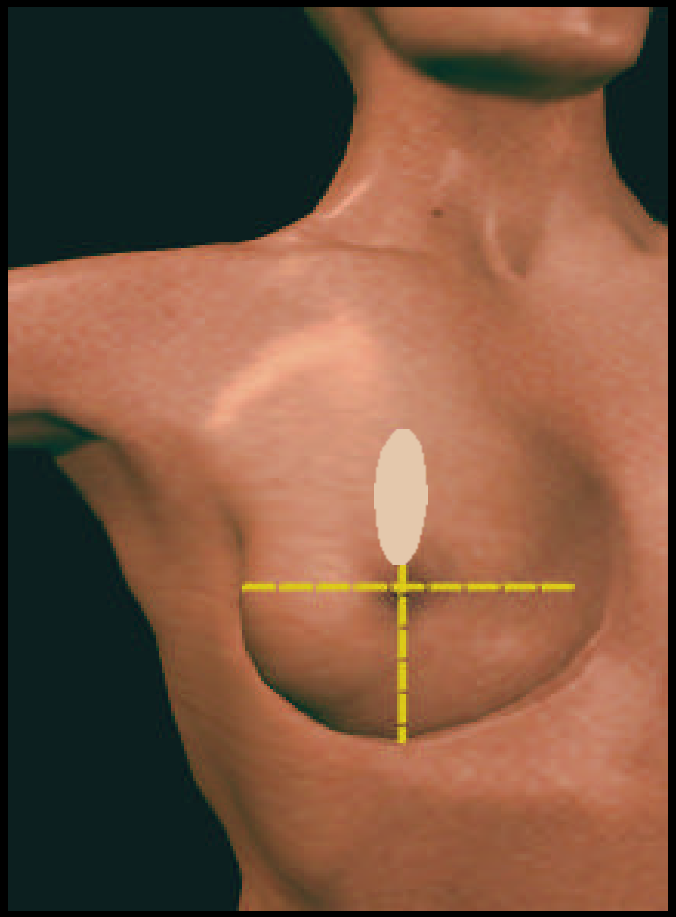
- MEDIAL LESIONS
  - patient is supine
  - ipsilateral armed is place over the patient's head

Technique: **Patient Position**



- LATERAL LESIONS
  - patient is opposite posterior oblique
  - ipsilateral arm is placed over the patient's head

Technique: **Patient Position**

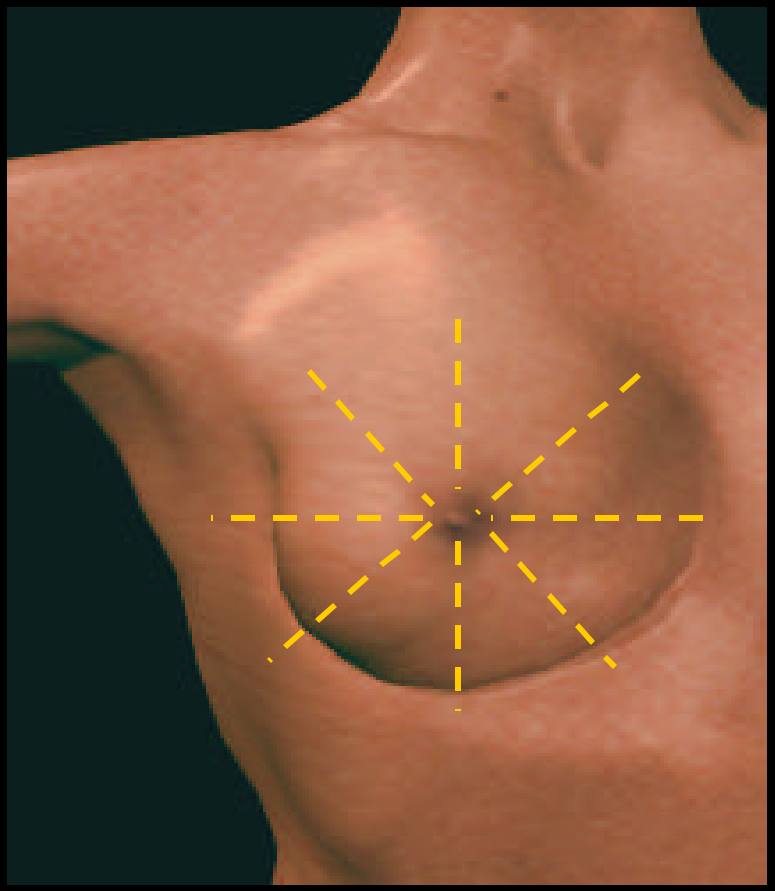


- SUPERIOR LESIONS
  - patient is SITTING
  - ipsilateral arm is placed over the patient's head

Technique: **Scanning**

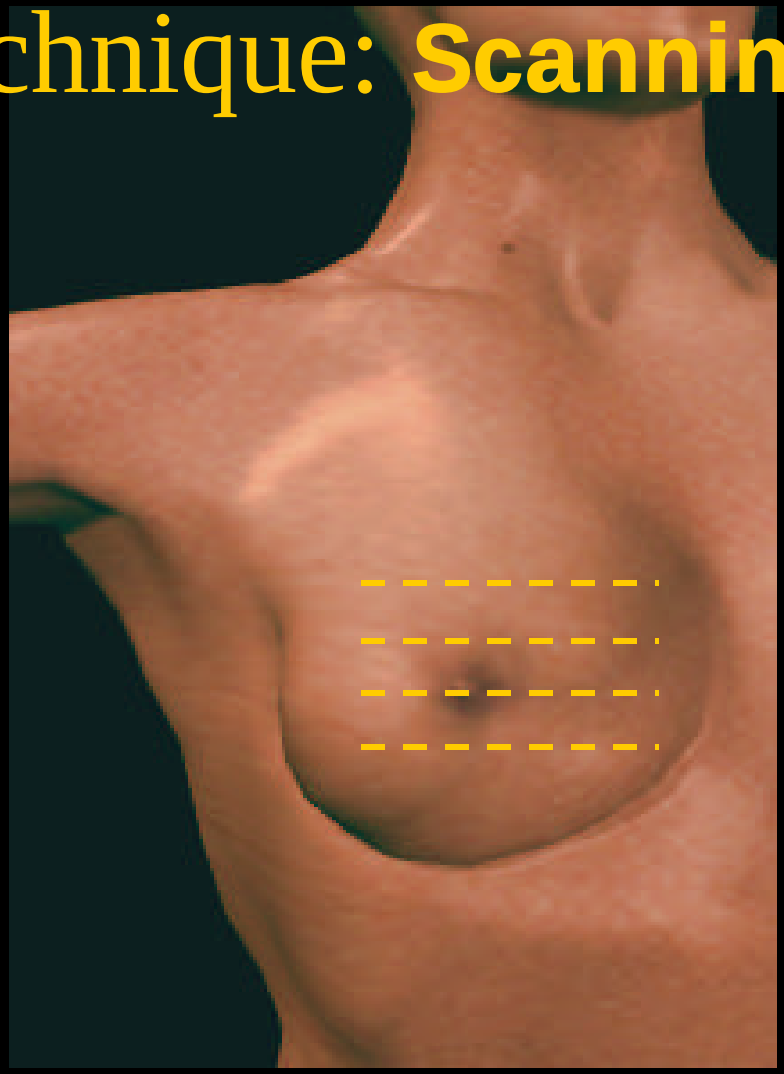
- Coupling Gel
  - liberal quantity
  - use gel warmer
- Apply gentle uniform pressure with the ultrasound transducer
- Increase transducer pressure for:
  - greater penetration
  - scanning the subareolar region

Technique: **Scanning**



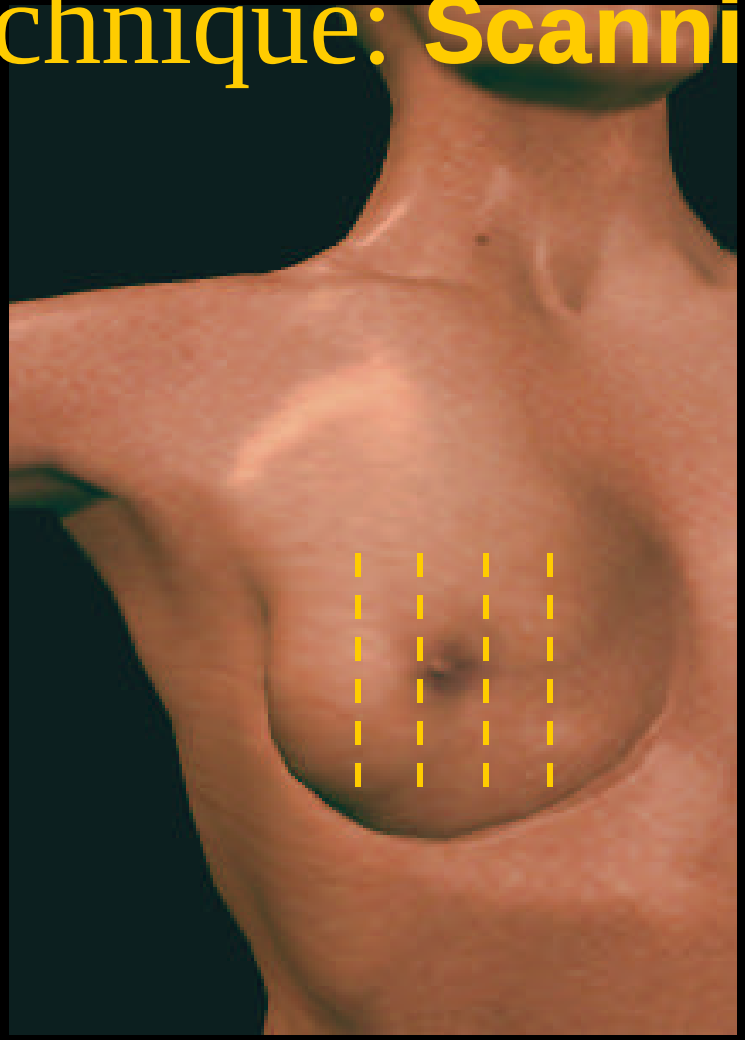
RADIAL

Technique: **Scanning**



TRANSVERSE

Technique: **Scanning**



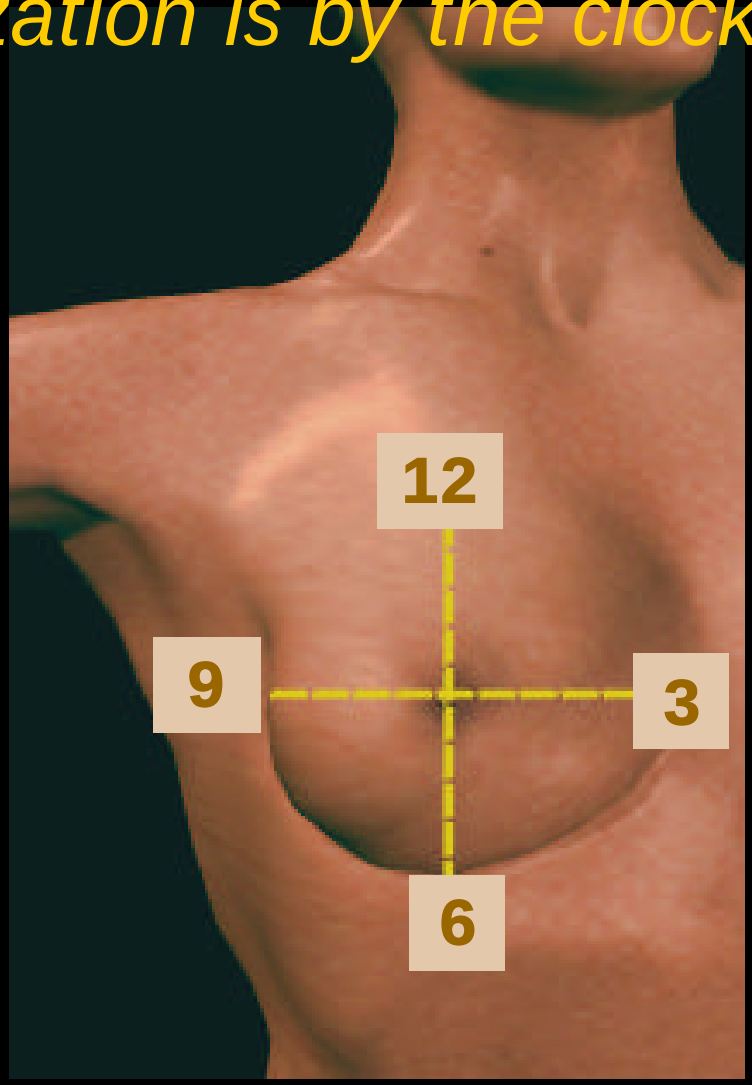
LONGITUDINAL

Technique: **Scanning**

- Lesion Location
  - allows for reproducibility for follow imaging
  - allows for reproducibility for interventional breast procedures

Localization is by the clock face.

Localization is by the clock face.



Technique: **Equipment Selection**

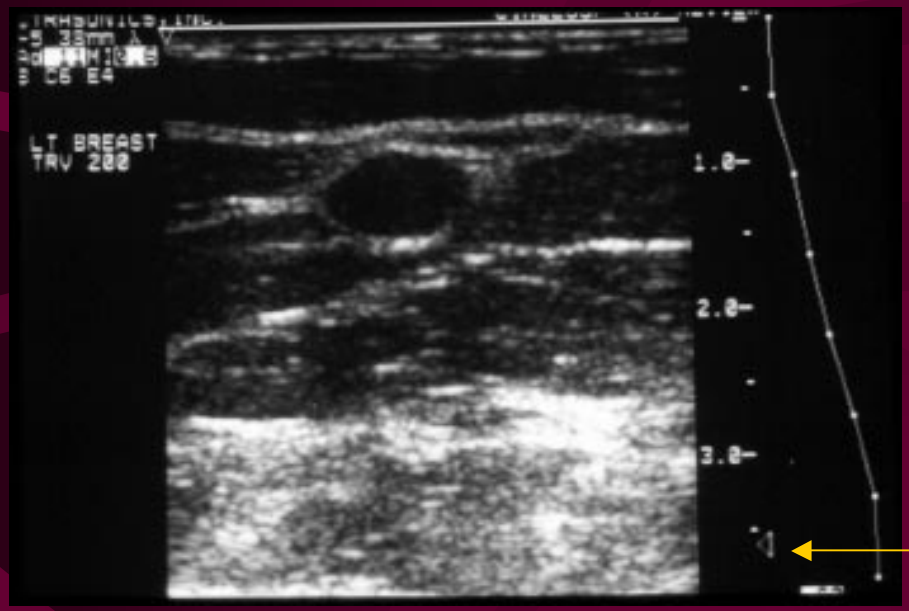
- Transducer
  - 7.5 MHz linear array or higher
- Power
  - 50 - 70%
- Gain/TGC
  - 50 - 70% Gain
  - TGC is midrange with no curve
- Focal Zones
  - minimum of three zones
- FOV/Depth/Zoom
  - Imaging depth adequate enough to visualize ribs and pleural membrane

Technique: **Equipment Selection**

- Gray scale
  - long scale, low contrast, high dynamic range
- Persistence
  - medium setting for most dynamic image and ease in scanning
- Edge effect
  - highest setting for best resolution
- Compression
  - low to medium setting to reduce noise but maintain the lowest usable echo

✷ *Mammary fat should be a medium gray from the overlying fascia to the retromammary space*

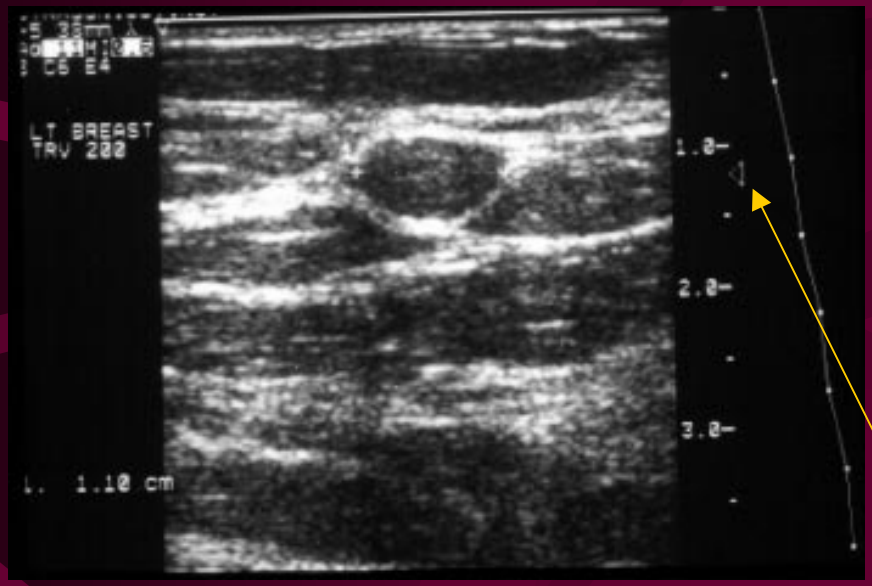
Focal Zones



- Image of a solid mass with the focal zone placed incorrectly

The focal zone depicted by the caret is at the bottom of the image.

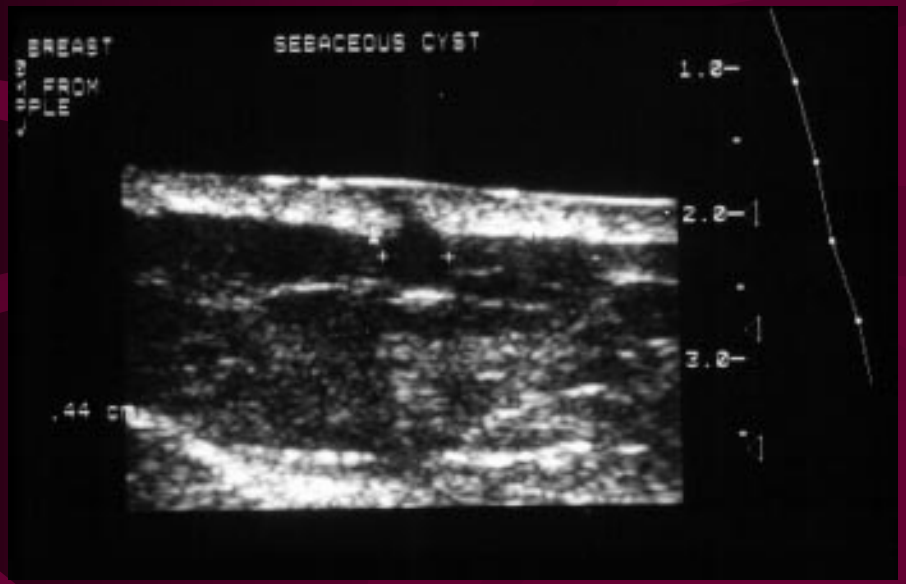
Focal Zones



- Image of the same solid mass with the focal zone placed <u>correctly</u>

The focal zone depicted by the caret is at the top of the image near the lesion.

Focal Zones
with Stand-off Pad

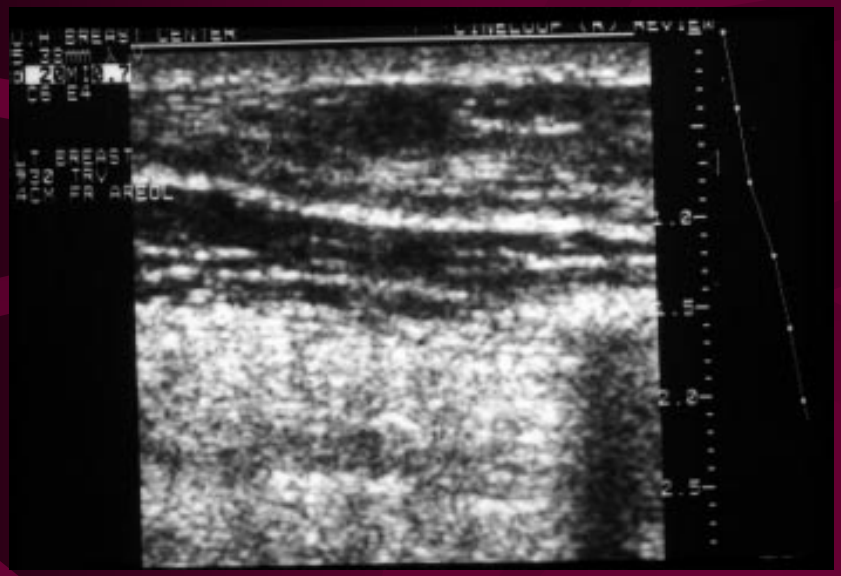


- For superficial lesions, the stand-off pad allows placement of the focal zone in the subcutaneous region

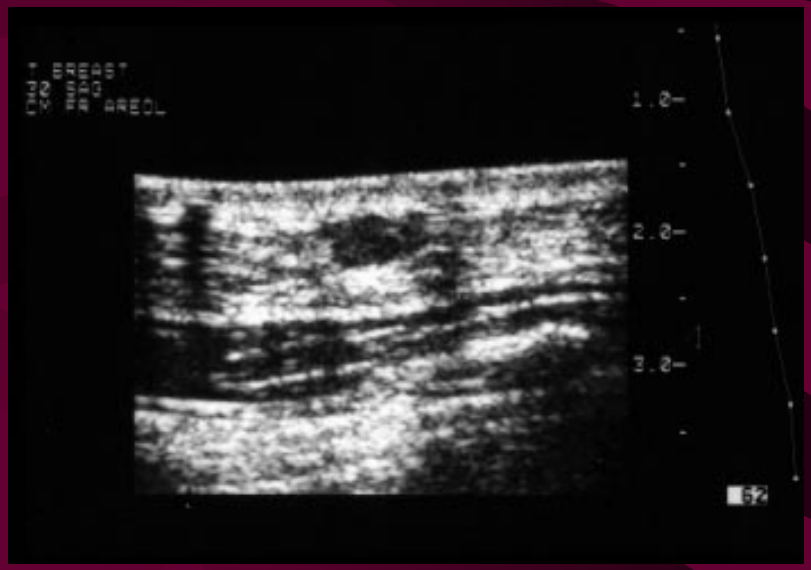
A sebaceous cyst.

Focal Zones
with Stand-off Pad

- Superficial mass



Without stand-off pad



With stand-off pad

Sonographic Breast Anatomy

Skin

Subcutaneous fat

Cooper's Ligaments

Breast parenchyma

Retromammary fat

Pectoralis muscle

Ribs

Pleura

Nipple

Skin

- Highly reflective band along the surface of the breast
- Normal thickness 2–3mm
- Bright linear echo at top of image

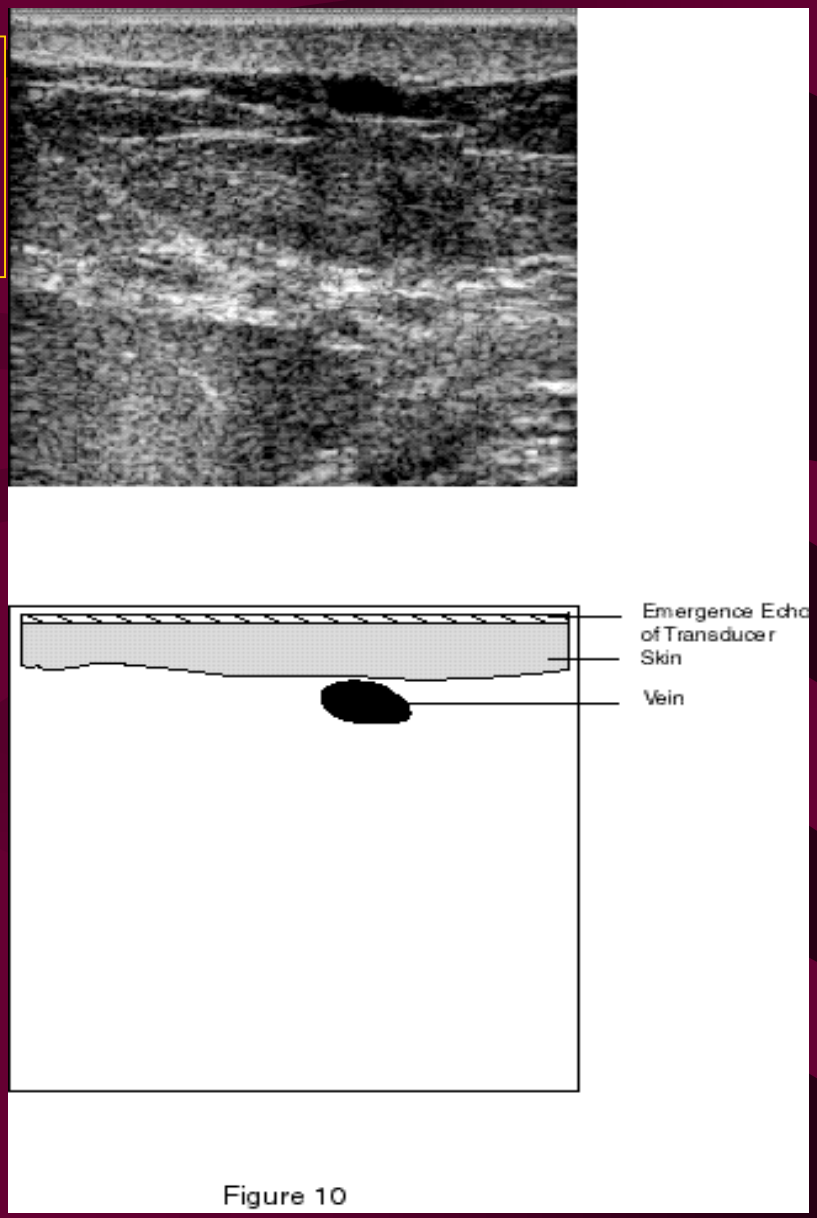


Figure 10

Subcutaneous Fat

- Lies between the skin and the breast parenchyma
- Quantity of fat varies
- Homogeneous

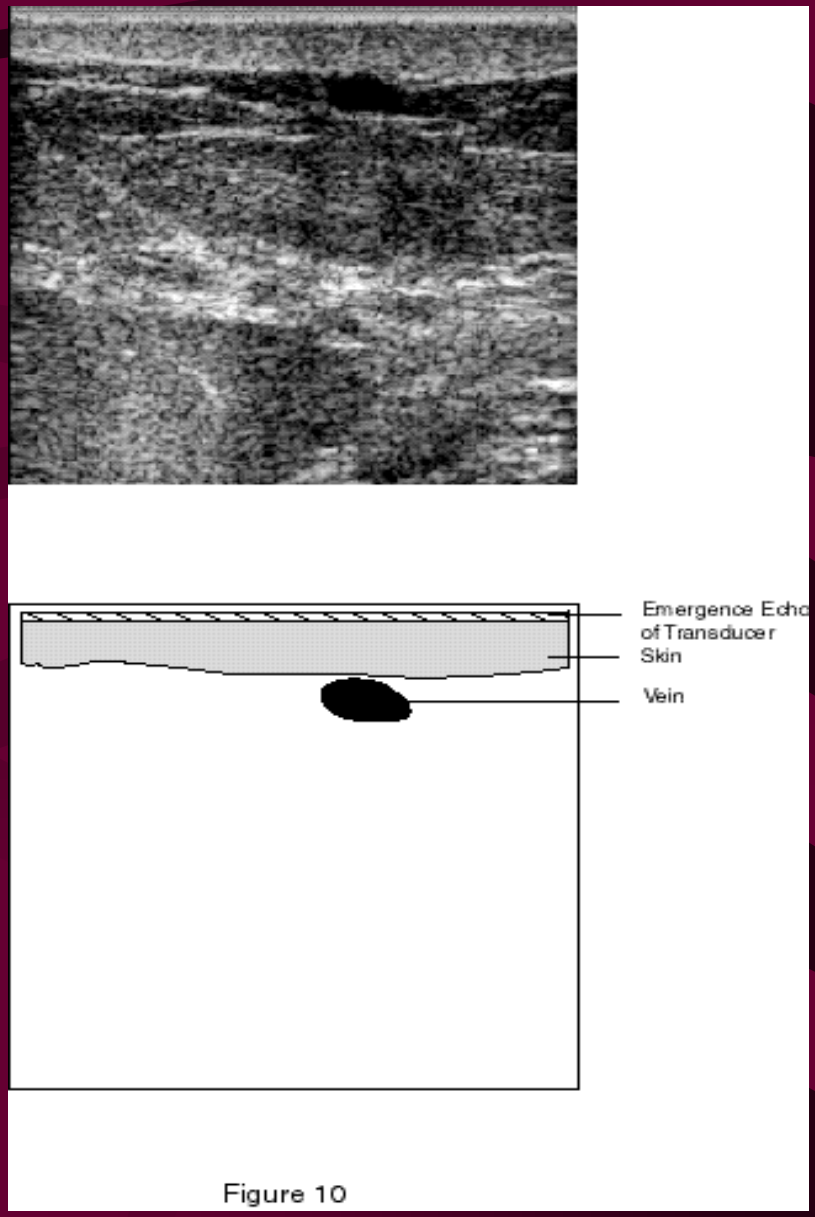


Figure 10

Cooper's Ligaments

- " Tent-like" structures
- Arise from breast parenchyma
- Echogenic

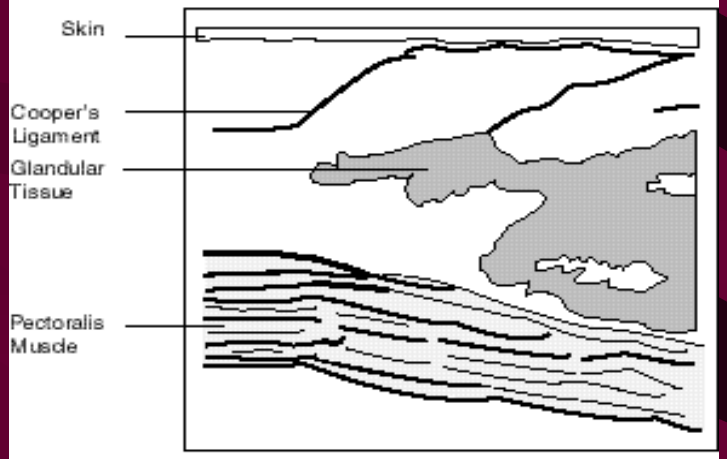
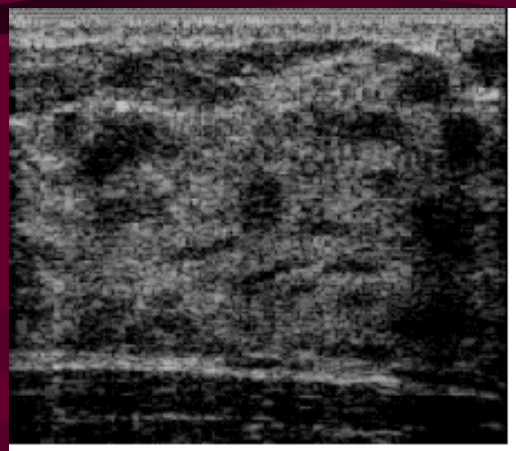


Figure 11

Parenchyma

- Lies beneath the subcutaneous fat
- Mixed homogeneity
- Four patterns:
  - fibrous
  - premenstrual
  - postmenstrual
  - pregnant



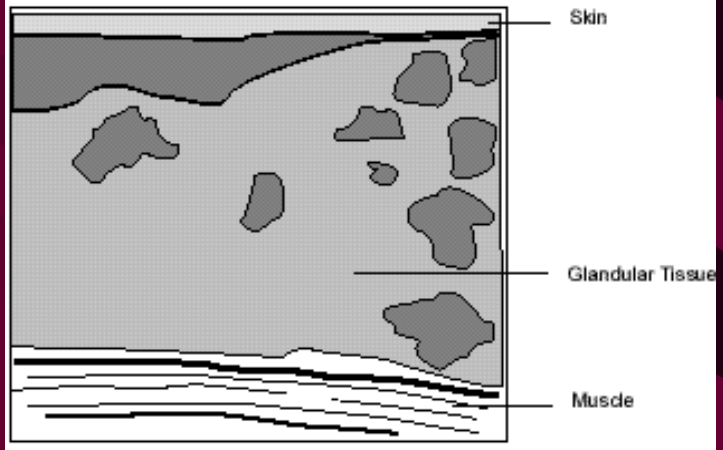


Figure 13

Retromammary Fat

- Posterior to parenchyma
- Forms a layer between the deep fascia plane and the pectoralis muscle

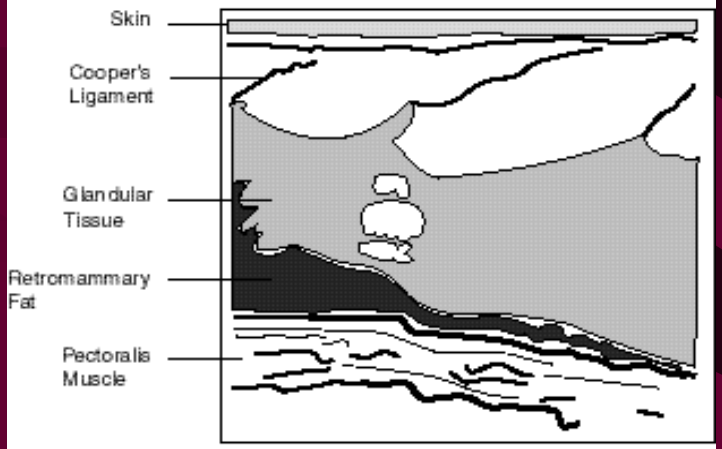


Figure 18

Pectoralis Muscle

- Anterior to ribs
- Sonographically imaged in the direction of their fibers

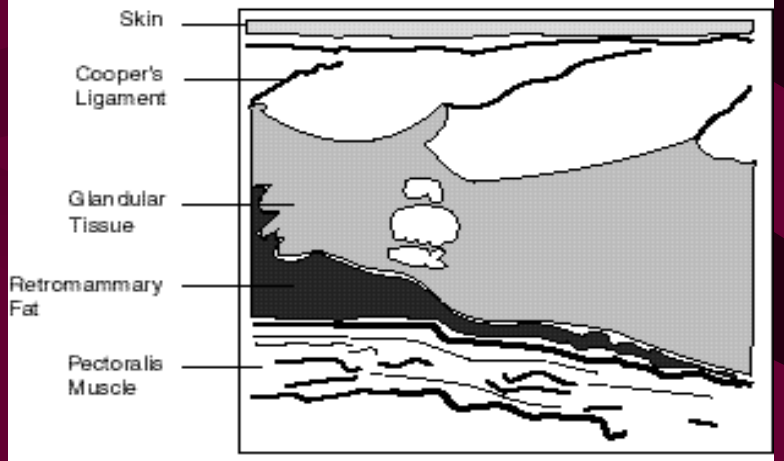


Figure 18

Ribs

- Easily identified bone attenuates causing an acoustic shadow

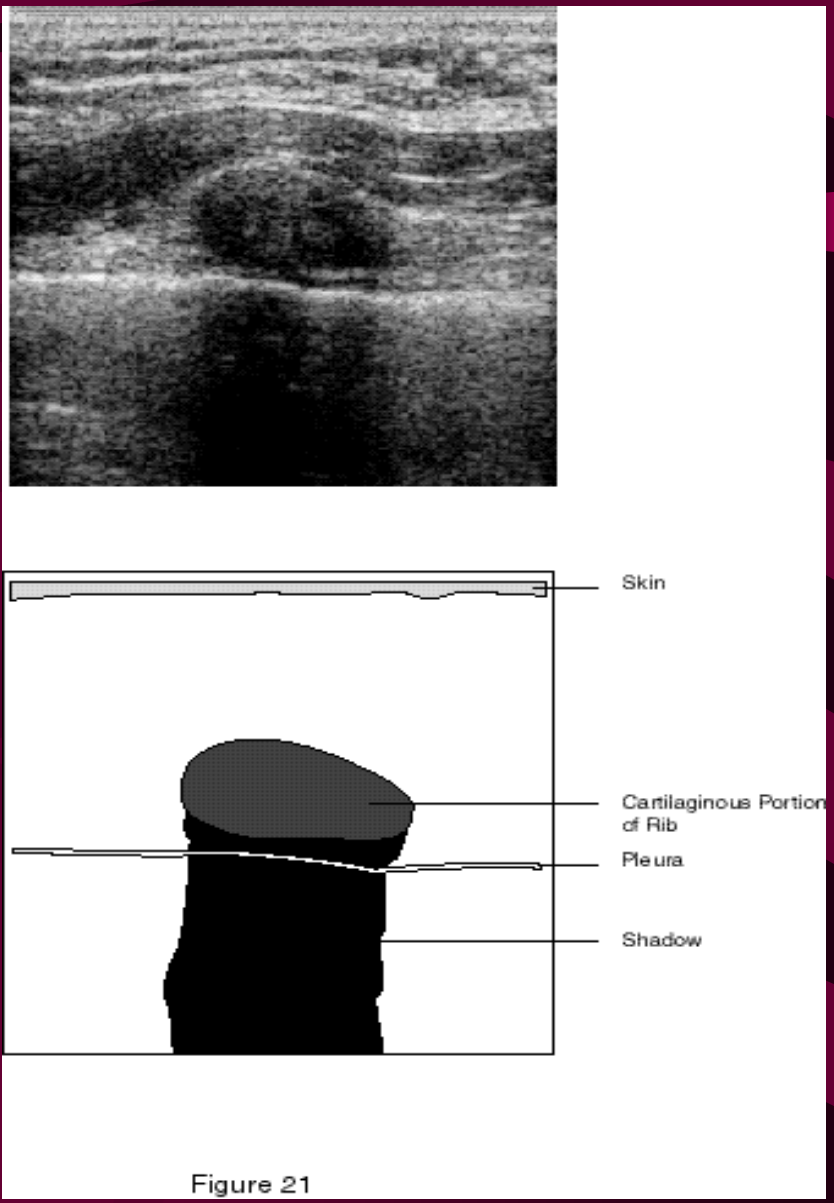
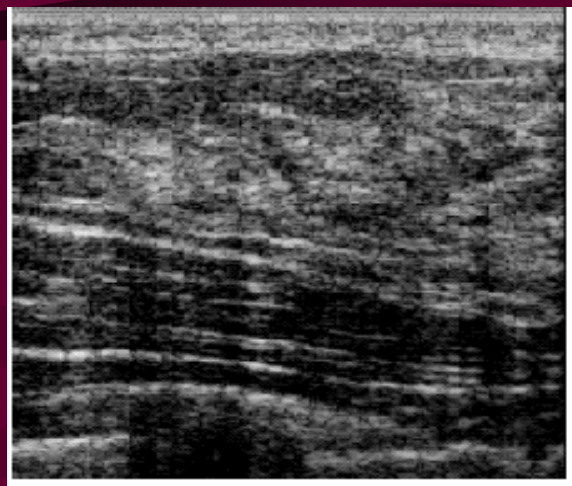


Figure 21

Pleura

- Linear echogenic line deep to rib
- Will move with respiration



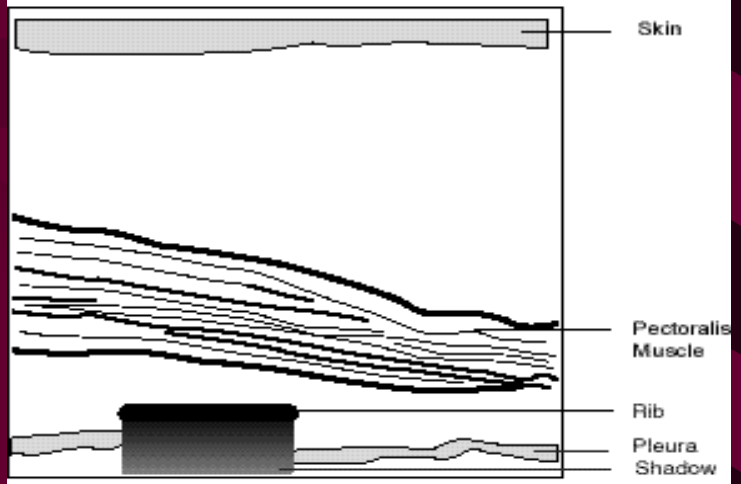


Figure 19

Nipple

- Consists of both dense connective tissue and connective tissue of the duct which can cause posterior acoustic shadowing

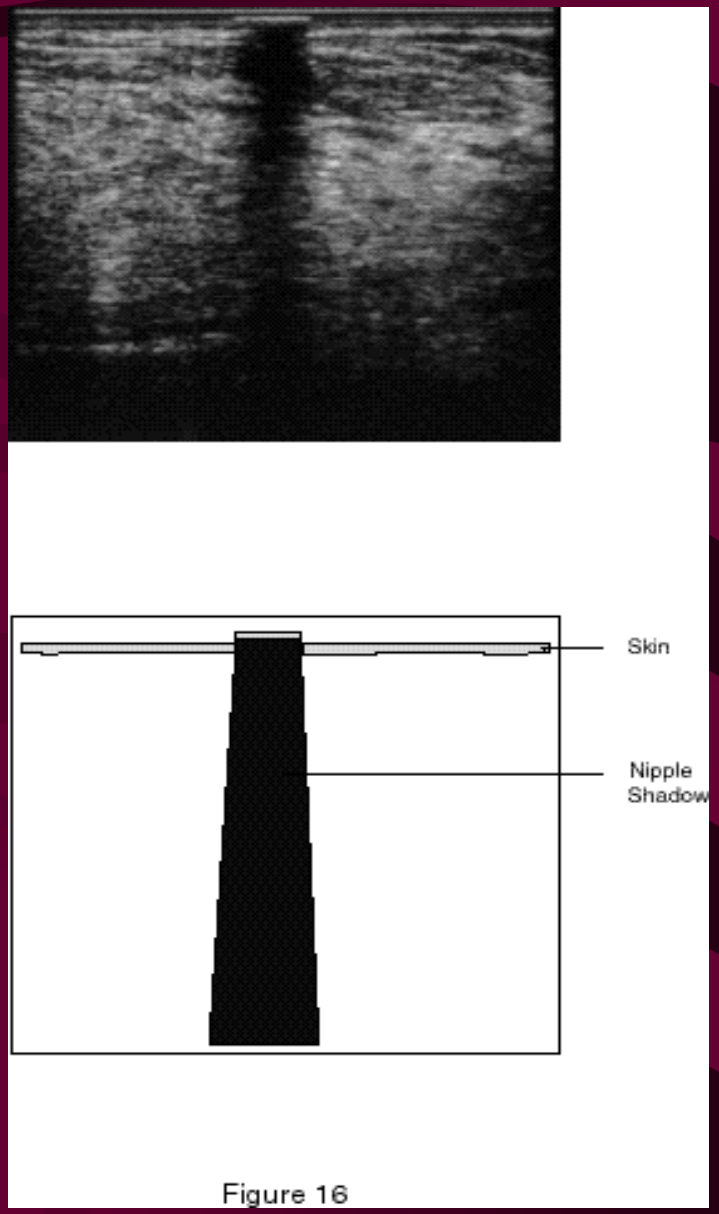


Figure 16

Lymph Node

- Solid nodule
- Ovoid
- Echogenic fatty hilum

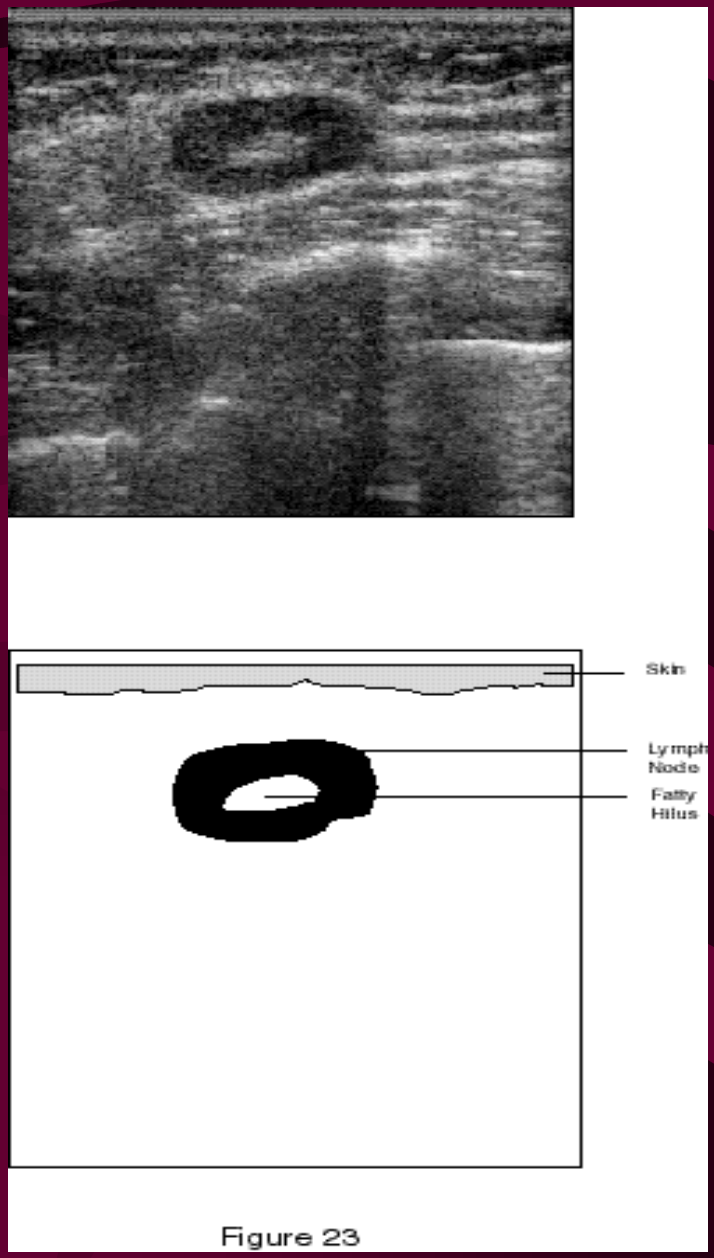


Figure 23

Duct

- Tubular branching structures
- Converge sub-areolar

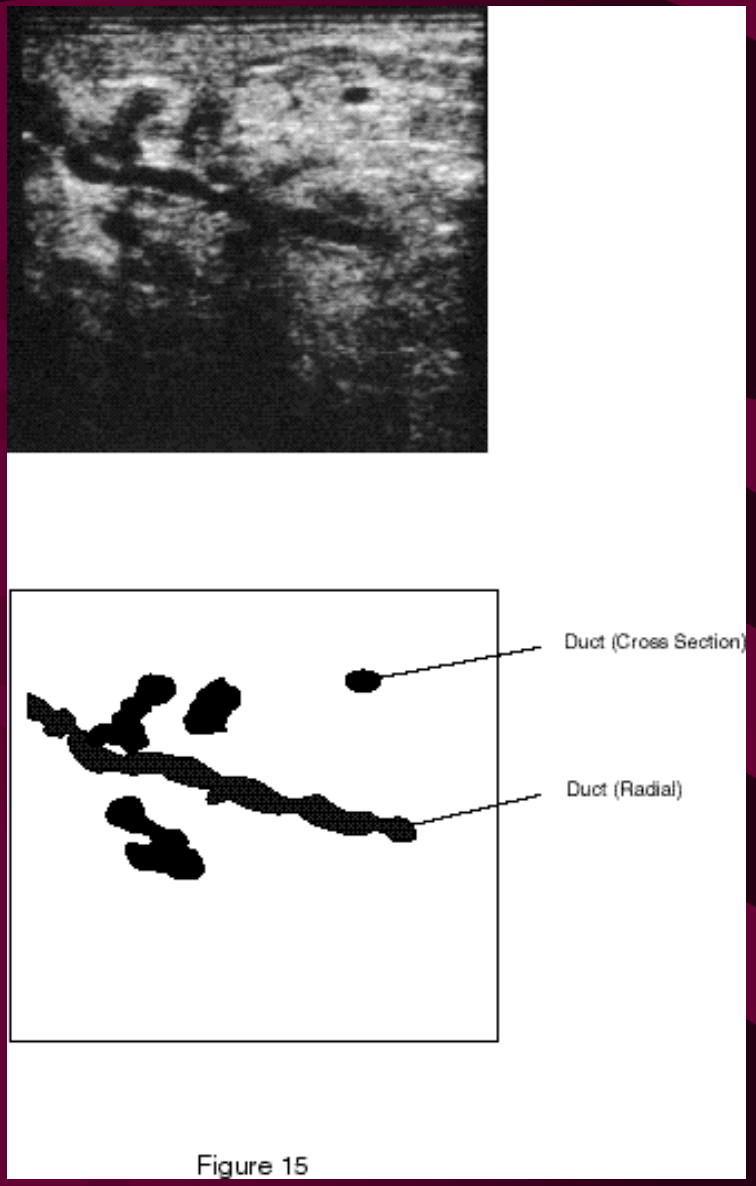
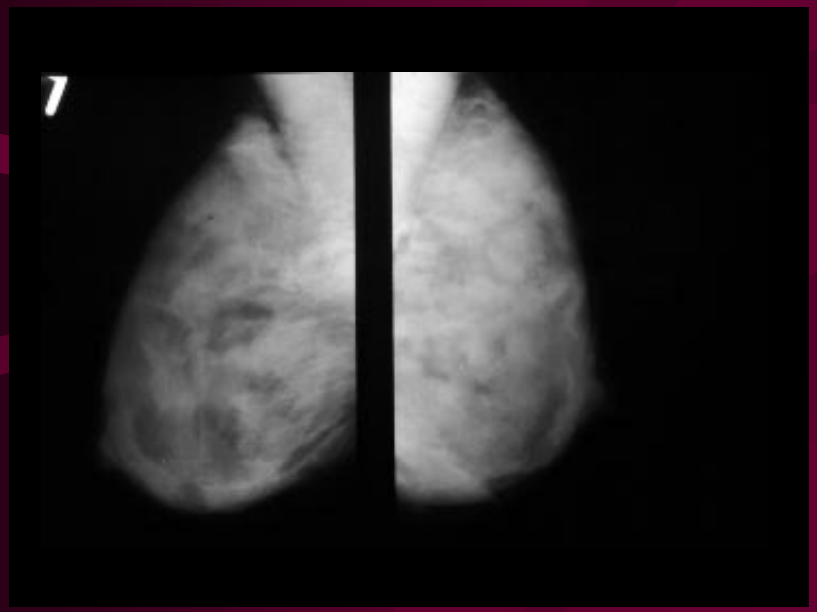
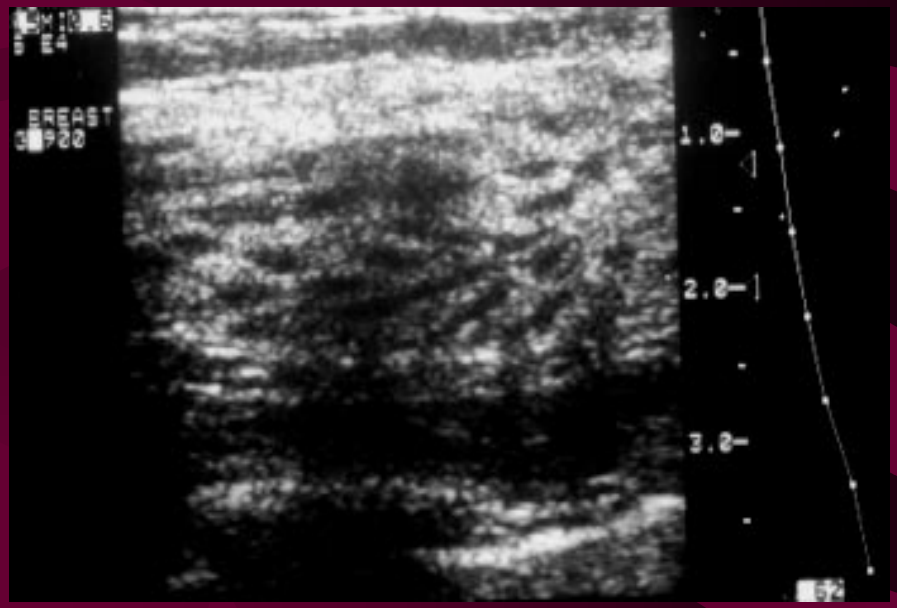


Figure 15

Breast Ultrasound and Mammographic Correlation

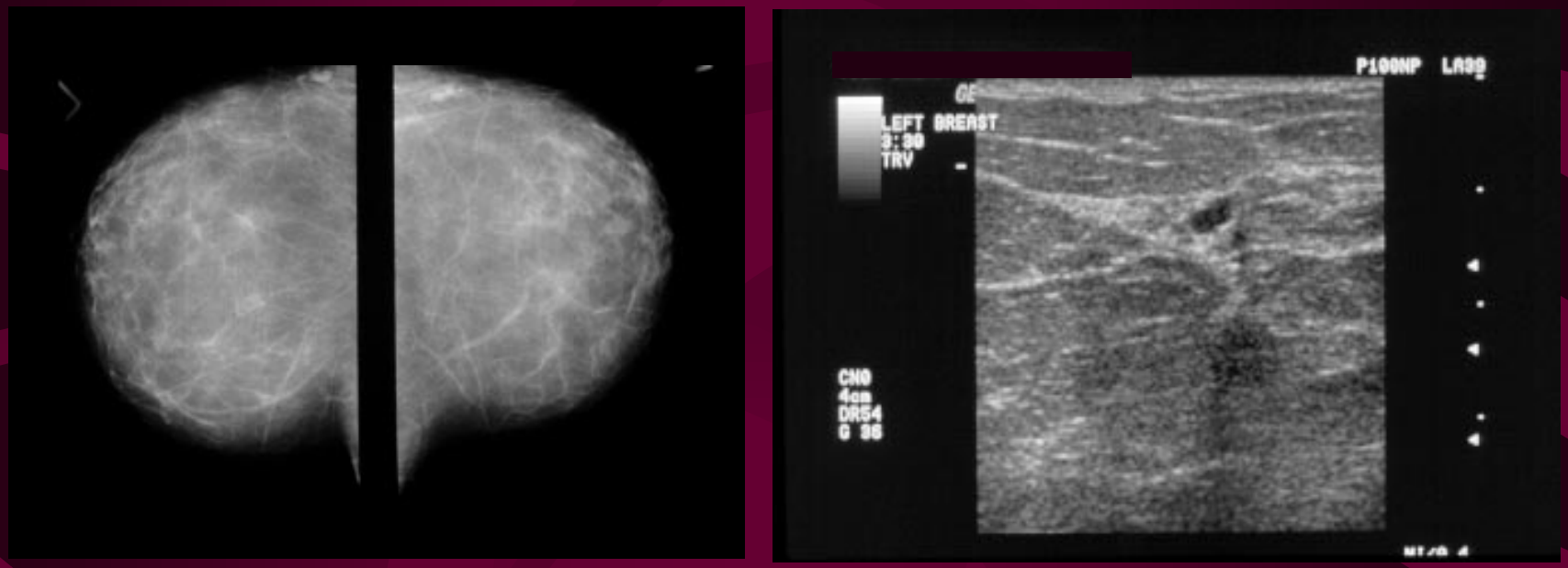




Dense Breast

Images courtesy of Emily Conant, MD

Breast Ultrasound and Mammographic Correlation



Fatty Breast

Images courtesy of Emily Conant, MD

Ultrasound of the Breast Indications

- Radiologic
  - Mammographic mass
  - Assymmetric density on mammo
- Physical
  - Mass
  - Thickening
  - Discharge or Infection
- Sono
  - Screening in dense breast / high risk

Ultrasound of the Breast

Recent studies show if strict criteria for lesion analysis are followed, specificity of ultrasound in determining benign or malignant reaches 70%.

Reference: Stavros AT, Solid Breast Nodules: Use of Sonography to Distinguish between Benign and Malignant Lesions. Radiology 1990

Breast Ultrasound

Imaging Characteristics

- size
- shape
- border definition
- internal echogenicity
- posterior enhancement
- architectural changes

Analytic Criteria
for Focal Lesions

- Margins
- Retrotumoral acoustic phenomena
- Internal echo pattern
- Echogenicity
- Compression effect on *SHAPE*
- Compression effect on *INTERNAL ECHOES*

Analytic Criteria
for Focal Lesions

Margins

- Malignant
  - indistinct, jagged
- Benign
  - distinct but smooth
  - sharp, jagged
  - sharp, smooth

Analytic Criteria
for Focal Lesions

Retrotumoral Phenomena

- Malignant
  - posterior shadowing
  - unilateral edge shadowing
- Benign
  - posterior enhancement
  - bilateral edge shadowing

Analytic Criteria
for Focal Lesions

Internal Echo Pattern

- Malignant
  - heterogeneous
- Benign
  - homogenous

Analytic Criteria
for Focal Lesions

Echogenicity

- Malignant
  - hypoechoic to fat
- Benign
  - hypoechoic
  - hyperechoic
  - isoechoic
  - anechoic

Analytic Criteria
for Focal Lesions

Compression Effect *on shape*

- Malignant
  - no change
- Benign
  - shape distortion

Analytic Criteria
for Focal Lesions

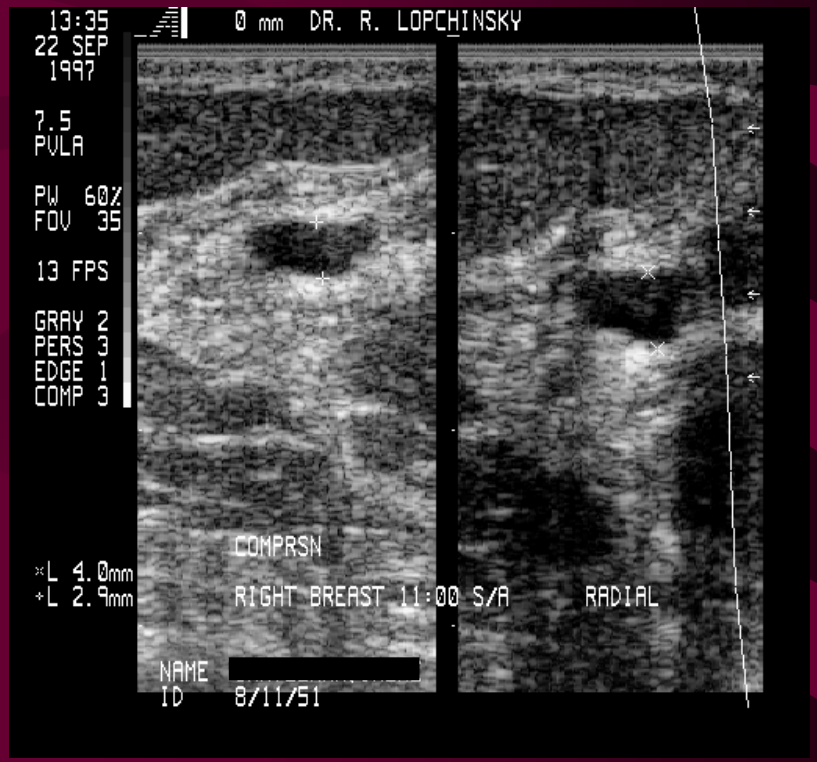
Compression Effect *internal echoes*

- Malignant
  - no change
- Benign
  - echoes become more homogeneous

Compressibility:

Complex cyst

- Change in size by more than 25% is likely to be benign
- Frequently lipoma or cyst

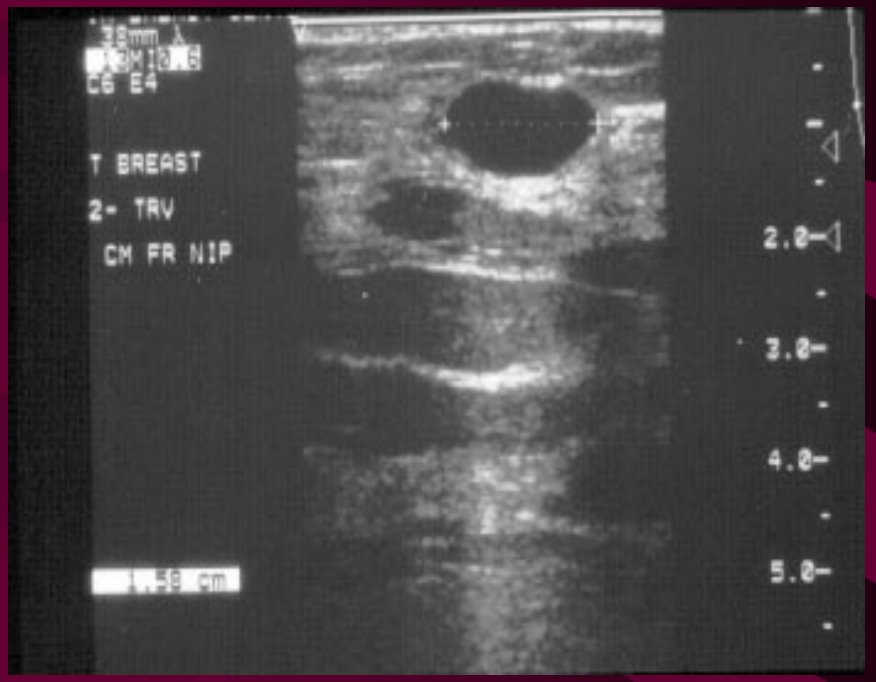


Breast Ultrasound

- Malignant Masses
  - variable walls
  - variable shapes
  - irregular borders
  - ill-defined borders
  - non-uniform
    - low-level distribution of echoes
- Benign Masses
  - round shape
  - oval shape
  - smooth, defined borders
  - uniform
    - low to medium distribution of echoes

Benign Breast Cyst

- Simple Cysts
  - anechoic
  - smooth, thin margins
  - posterior acoustic enhancement



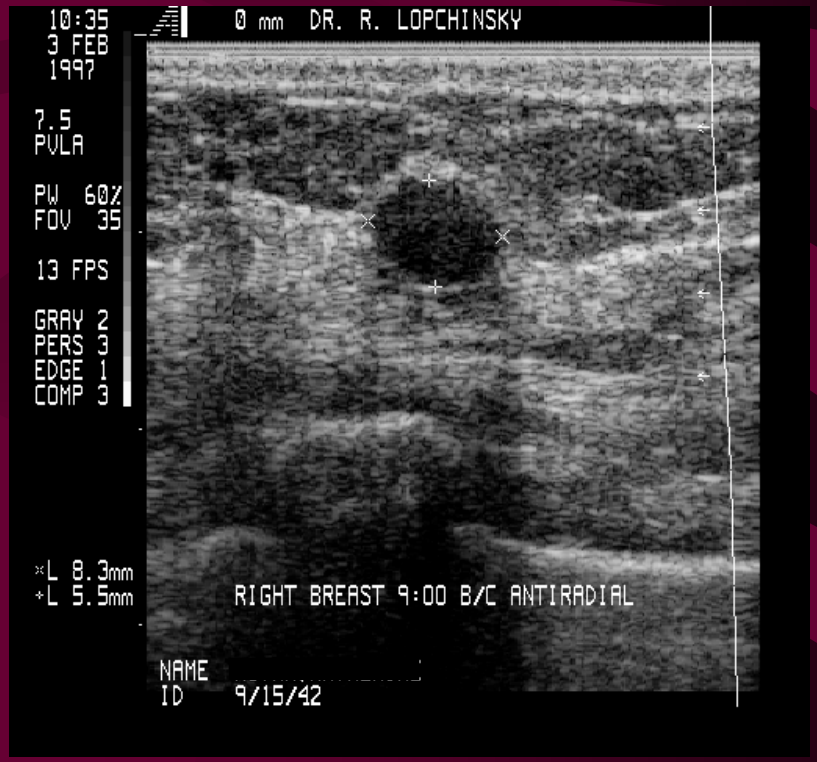
Images courtesy of Emily Conant, MD

<u>Common exceptions</u>:

- *hypoechoic (proteinaceous, calcium or blood)*
- *septations*
- *lack of posterior enhancement (lesion is deep or against chest wall)*

Shape: Round

- Very round lesions are usually cysts despite some echos



Complex Lesions

- Not completely anechoic
- Well circumscribed
- Thinly encapsulated
- Enhanced through transmission

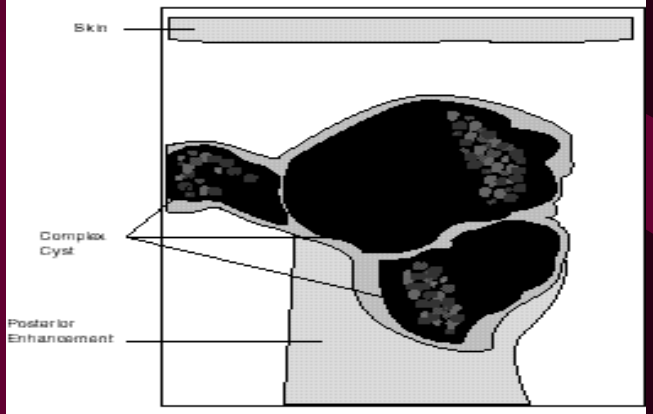


Figure 38

Lesion Analysis
Solid Masses

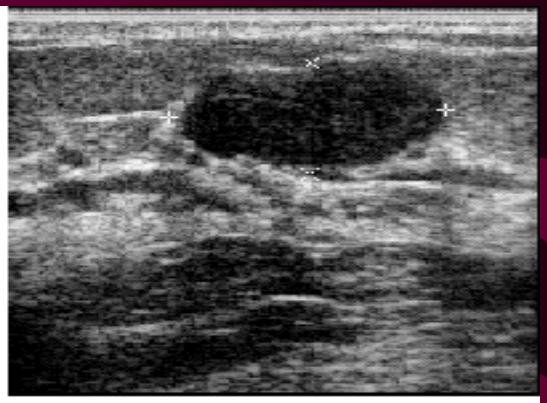
Benign Characteristics

- Ellipsoid shape
- Thin definable capsule
- Two or three lobulations
- Hyperechogenicity
- Absence of Malignant characteristics

Reference: Stavros AT et al. Solid Breast Nodules Use of Sonography to Distinguish between Benign and Malignant Lesions.

Solid Lesions - Benign

- Round or oval shape
- Smooth defined borders
- Uniformly low/medium level internal echoes
- Minimal attenuation *if any*
- Multiple lobulations



Solid Mass - Malignant

- Irregular shape
- Irregular/ill-defined borders
- Almost anechoic
- **Angular margin**
- **Taller than wide**

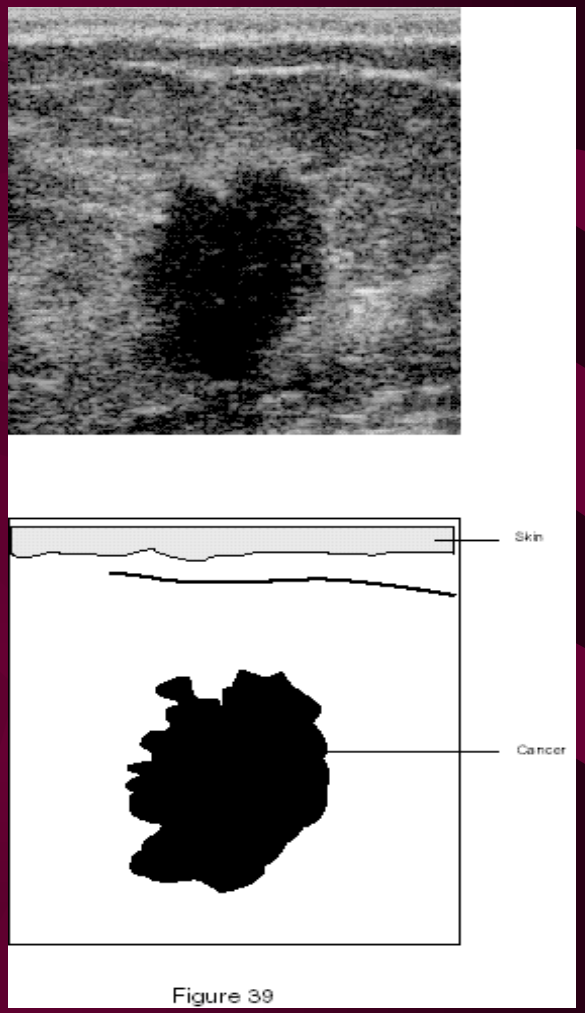
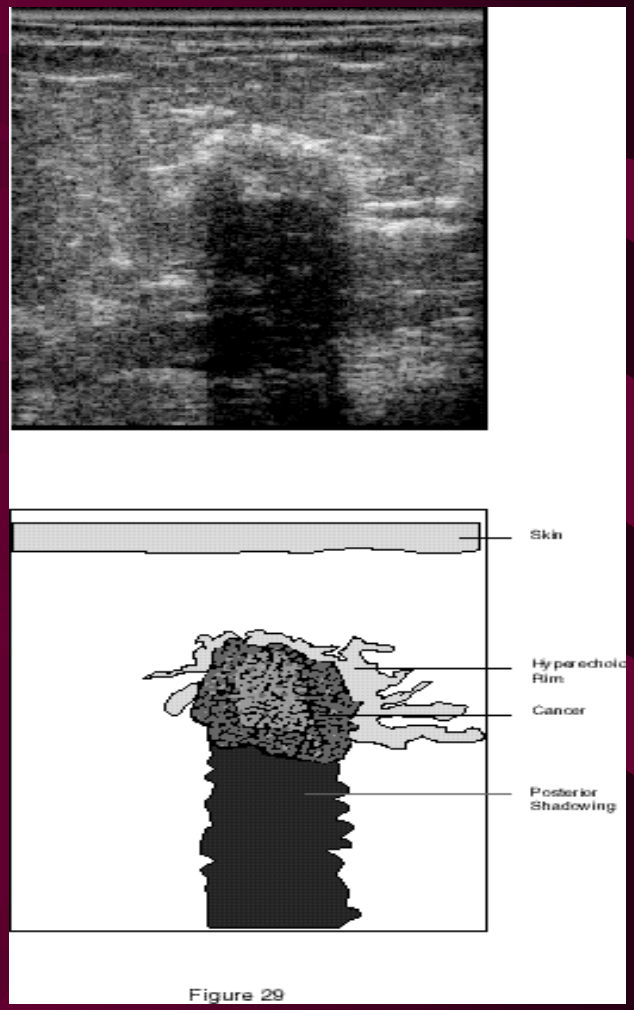


Figure 39

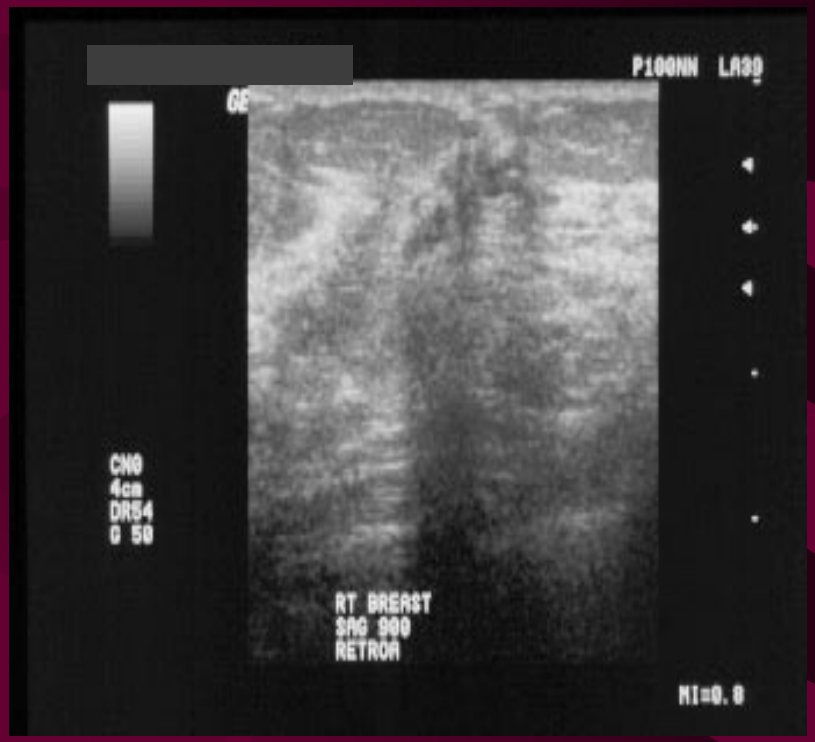
Solid Mass - Malignant

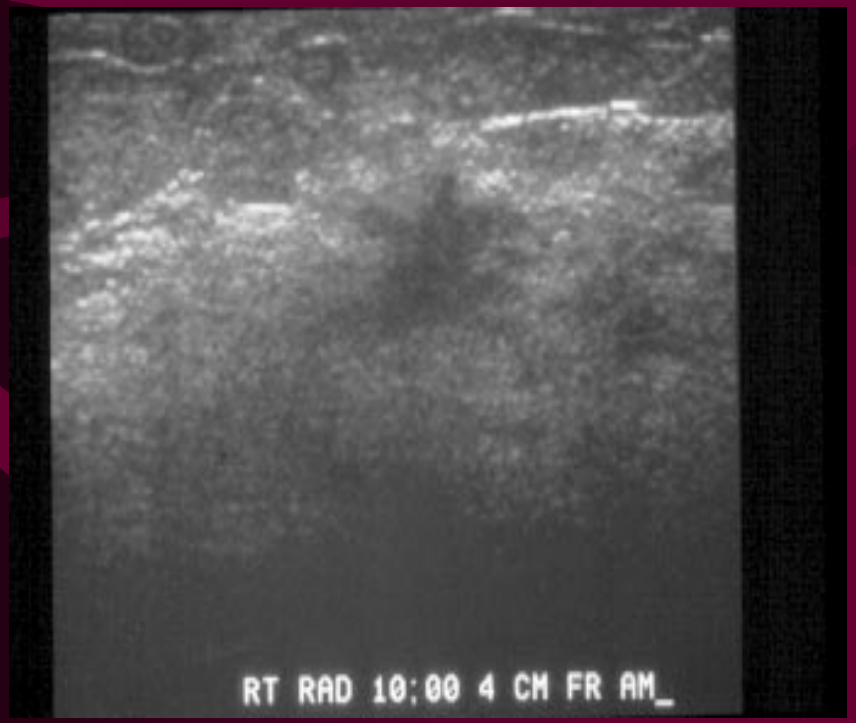
- Irregular shape
- Irregular/ill-defined borders
- Almost anechoic
- **Thick echogenic rim**
- **Posterior shadowing**



Solid Mass - Malignant

- Ductal extension





- Spiculations

Benign vs. Malignant

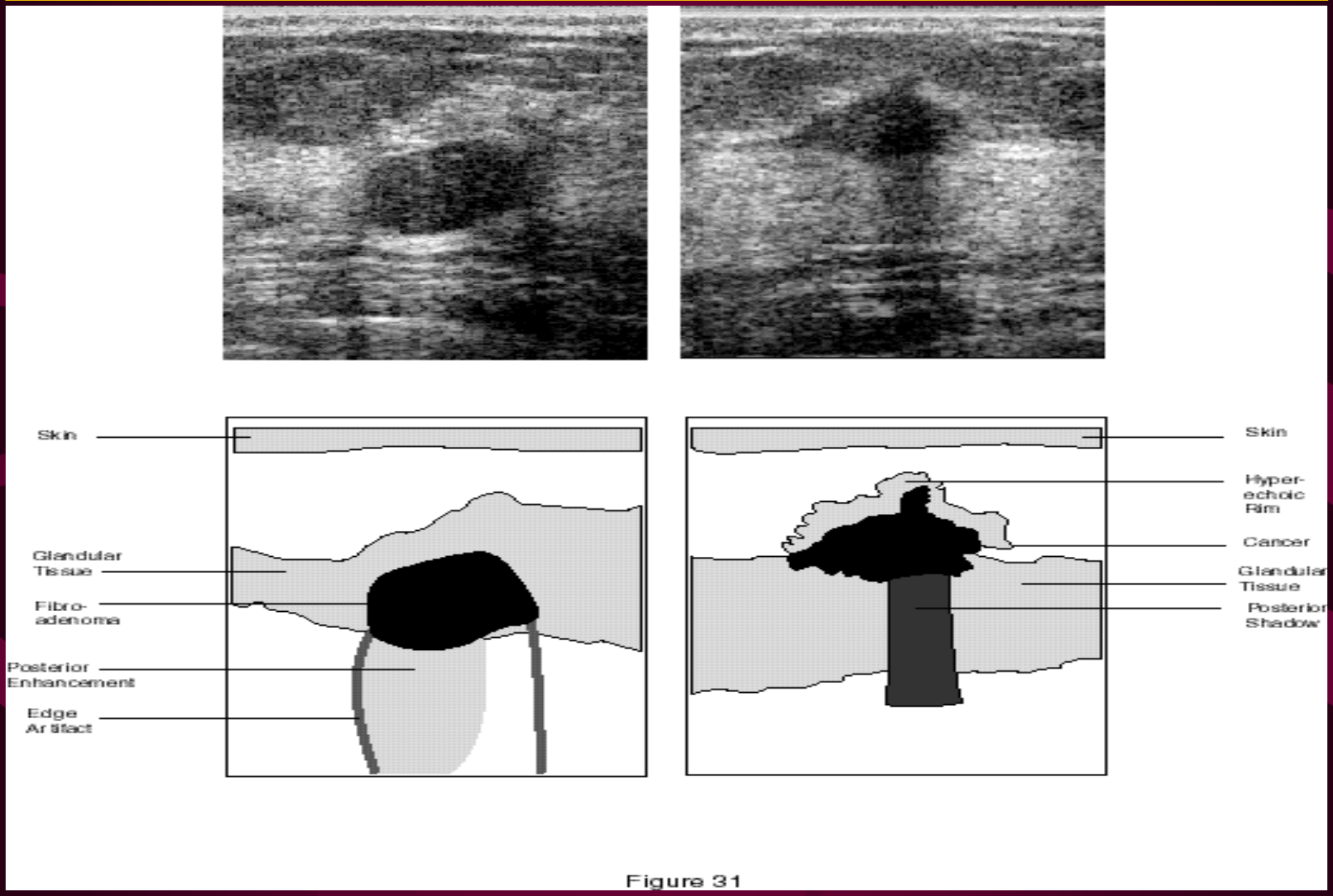


Figure 31

Malignant vs. Benign

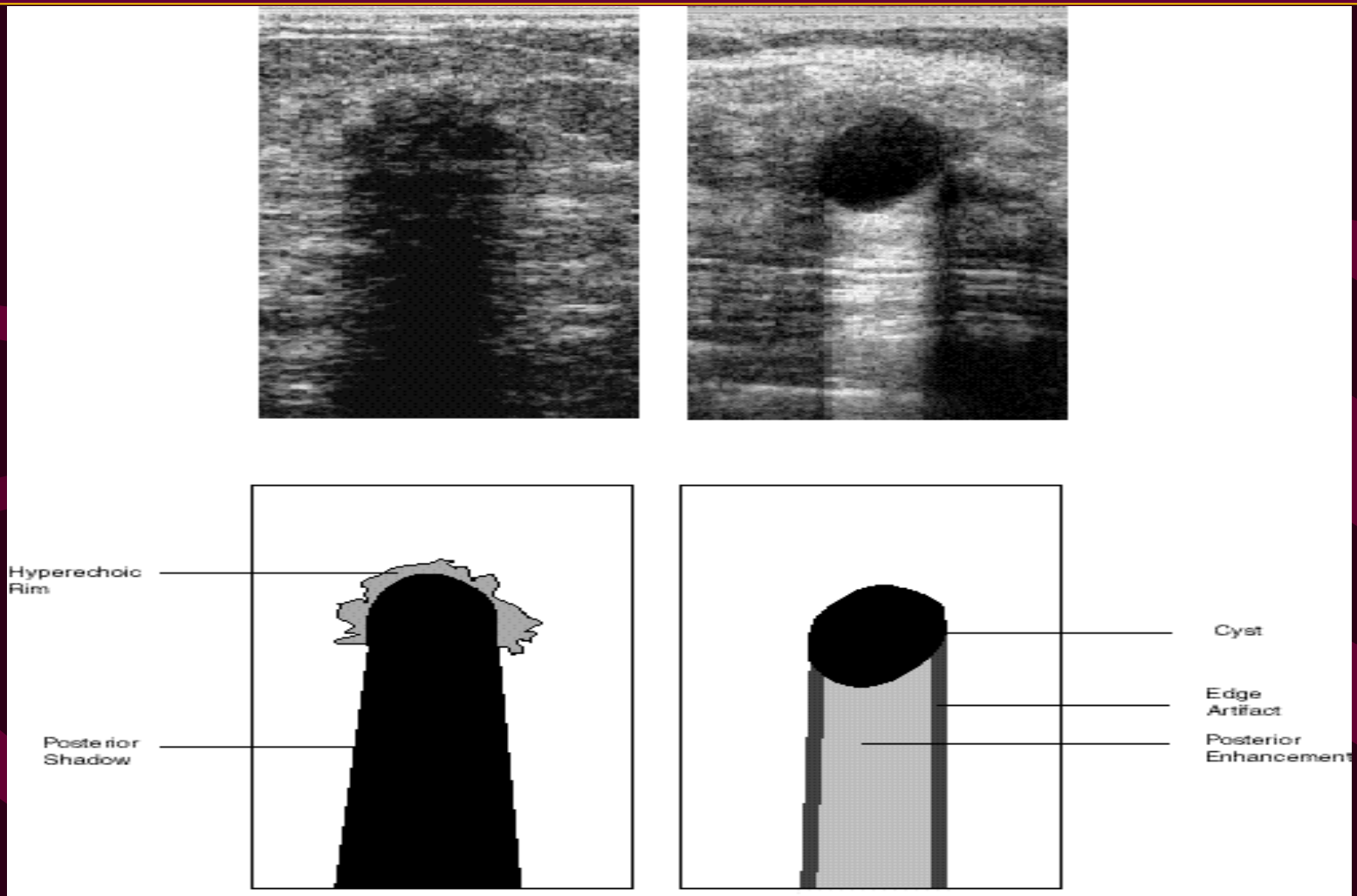


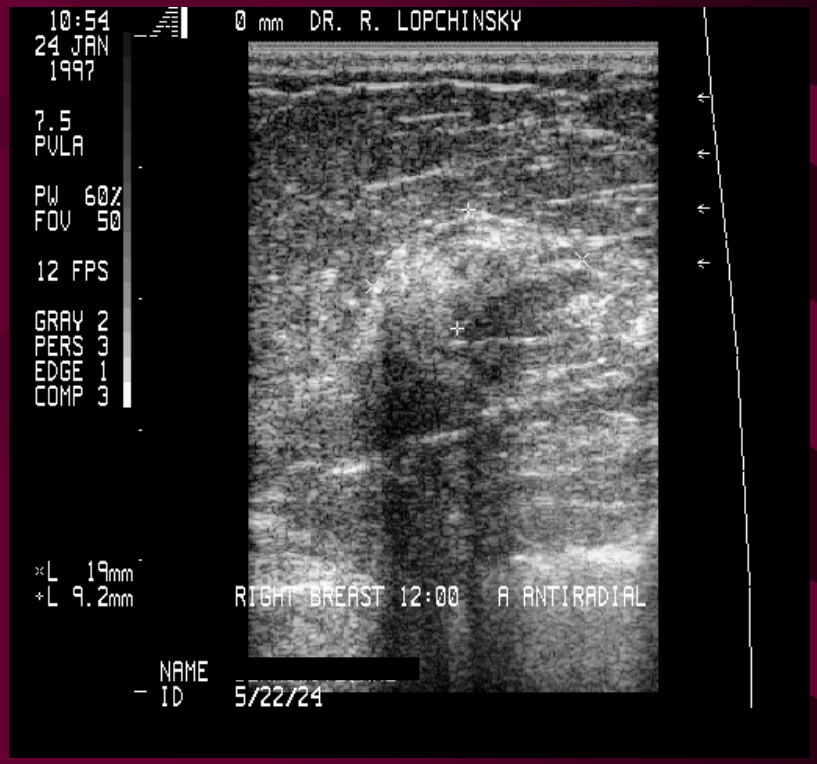
Figure 34

TO BE DEFINITELY BENIGN

- Absence of any malignant characteristics
  - spiculation, taller-than-wide, angular margins, shadowing, branching pattern, calcifications
- One of the following
  - hyperechoic
  - thin, echogenic capsule + ellipsoid shape
  - thin, echogenic capsule + 3 or less lobulations

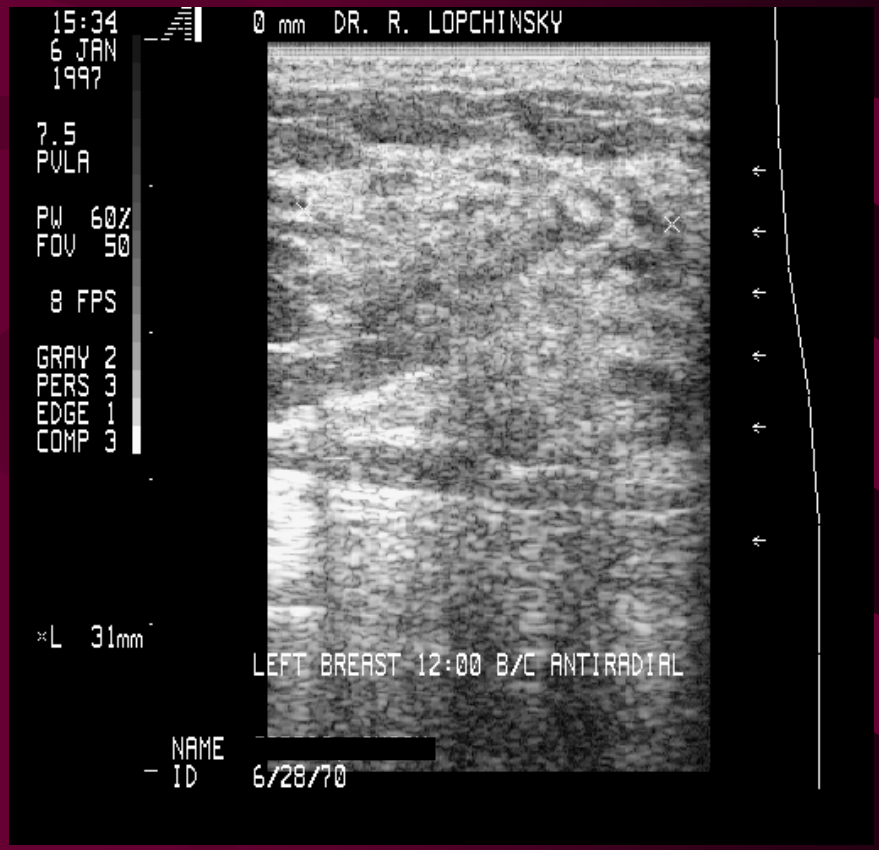
Palpable Thickening:
Localized Dense Breast Tissue

- Differentiate between dense tissue and a real abnormality
- Can obviate the need for open biopsy



Evaluation of Firm thickening

- Hyperechoic areas are benign
- an additional piece of evidence for benign dx
- FNA was performed on palpable thickening to confirm dx



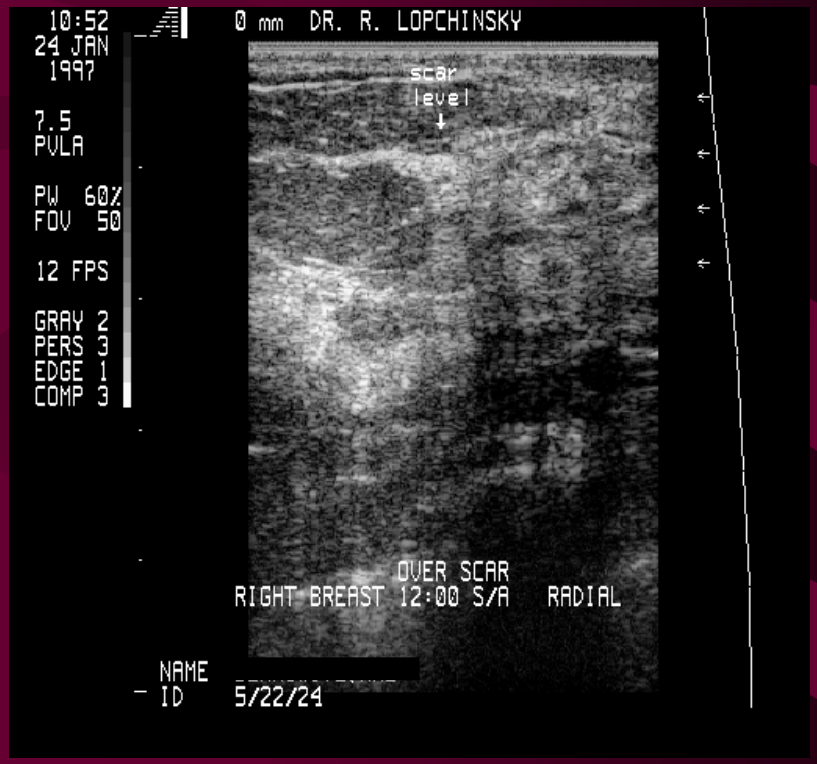
Evaluation of Firm Thickening

Fatty breast tissue

- Relatively easy to see any abnormality unless mass is isoechoic with the fat
- (Ligaments may cause shadows suggesting cancerous lesions)

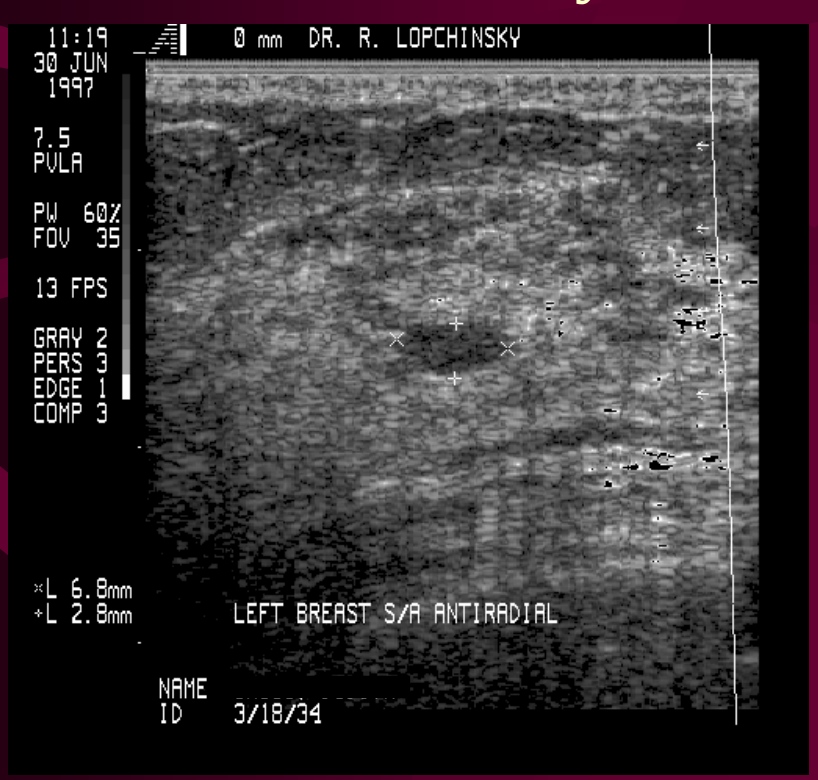
Unusual Findings:
Scar

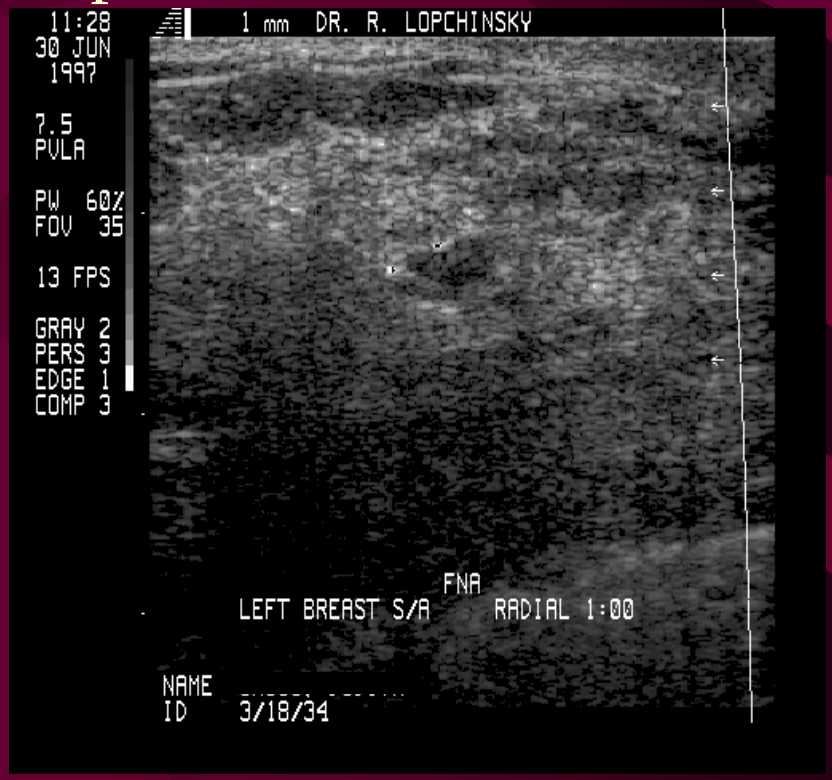
- Scar tissue causes marked shadowing mimicking cancer



Unusual Finding:
Enlarging Lymph Node

- H/O ca Rt, LUOQ “lymph node” increased from 7- > 9 mm over 2 years. FNA performed





Unusual Finding: Fat Necrosis

New mass after TRAM flap

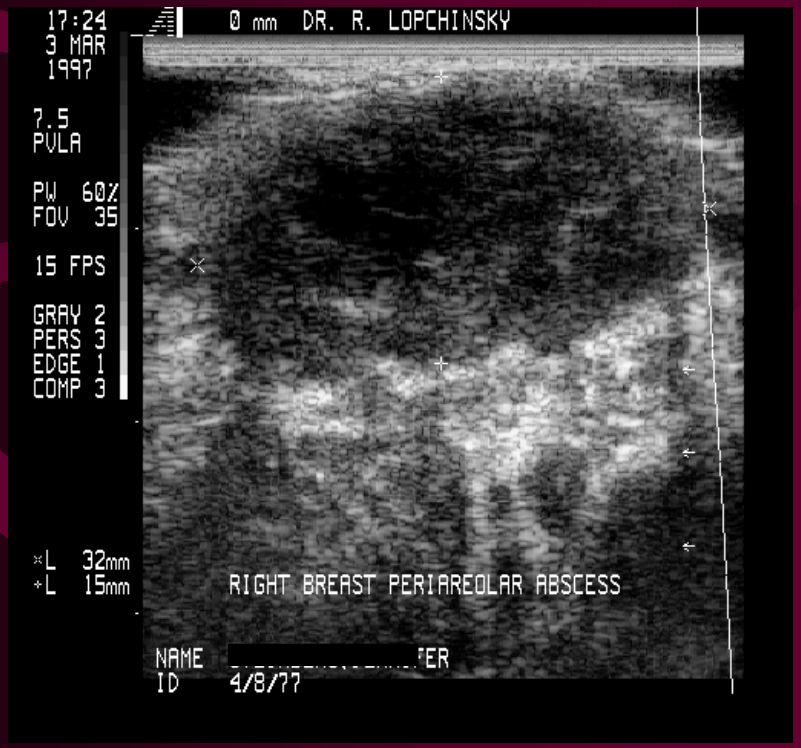
- 42yo developed new mass in skin flap above TRAM 9 months after surgery

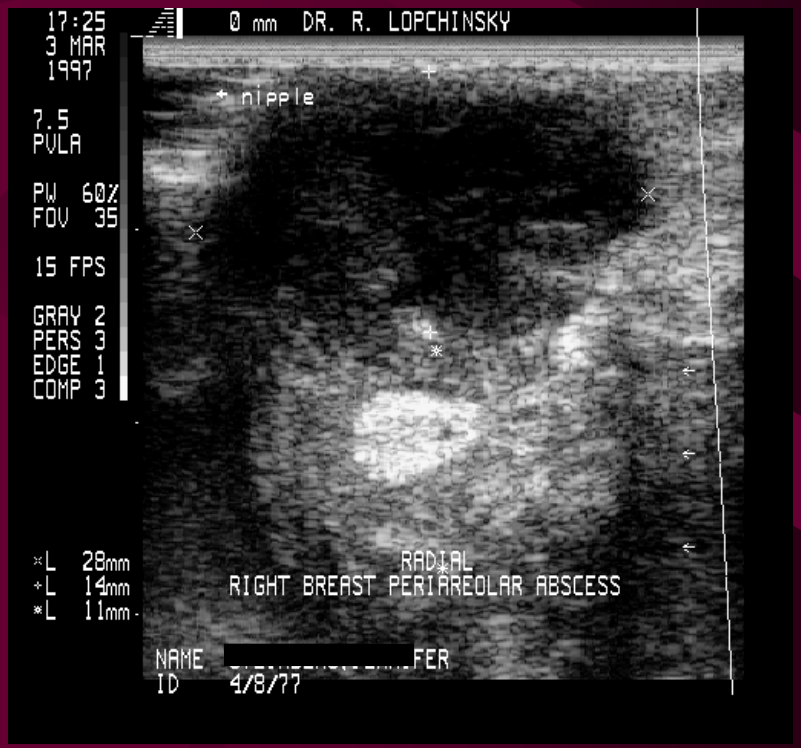
Unusual Finding: Fat Necrosis
Postreduction

- 24yo post reduction mammoplasty

Unusual Finding: Abscess

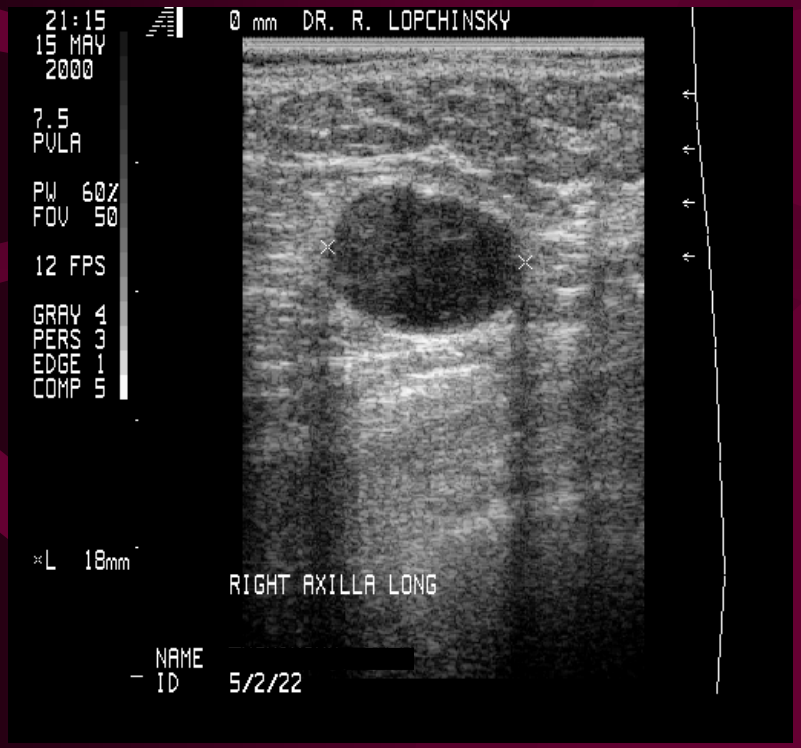
- 22yo infection: r/o abscess

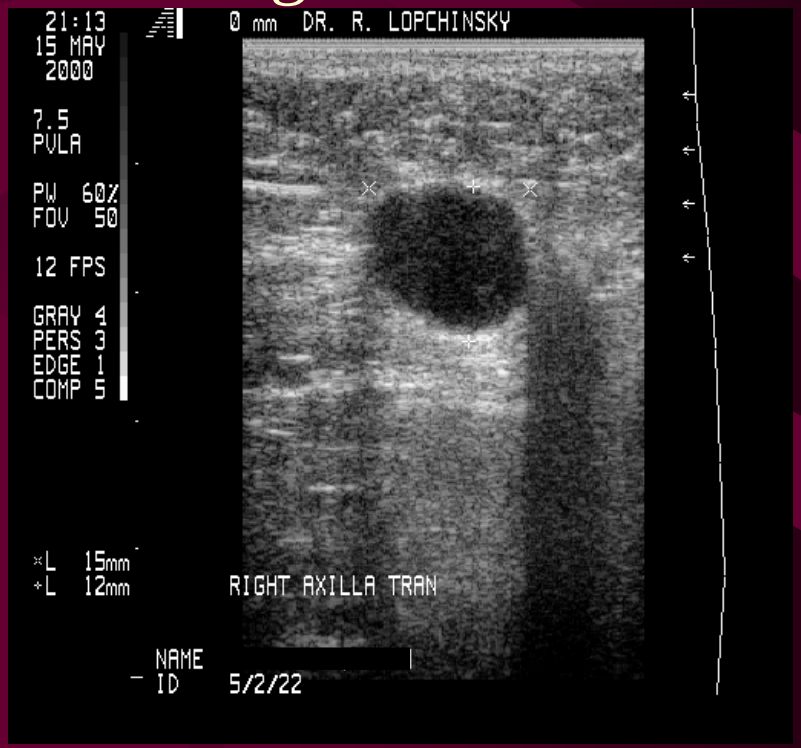




Unusual Finding:
Axillary Seroma

- S/P Right Lumpectomy + Sent Node + RT
- Mass in axilla 4 wk after finishing RT





Unusual Finding:
Axillary Seroma

- Best way to resolve issue