Breast Ultrasound Imaging and Mammographic Correlation

Marta Thorup, RDMS (BR) (AB) (OB/GYN), RVT
What kind of **Breast Sonographer** do we want to be?

We want to be the **BEST** we can be!

What can WE DO to be the best breast sonographers in North Carolina?

**We are doing it today!**
Breast Ultrasound Imaging and Mammographic Correlation

Objectives

- ARDMS Breast Registry
- ACR Lab Accreditation and Guidelines
- Mammography
- BIRADS system and BDV designation
- Breast Anatomy and Pathology
- Ultrasound Breast Imaging
- Mammography and Sonography Correlation
- Mass Localization and Triangulation
- Tips and Tricks
- Practice
• The Breast Registry exam tests your basic mammography knowledge and essential sonography skills.
• Registrant must first pass “Physics” exam, then take the Breast exam within five years.
• The Breast exam assesses knowledge, skills and abilities in the areas of normal and abnormal breast tissue found with screening and diagnostic mammography.
• The breast exam is 3 hours and contains 170 multiple choice questions.

First-time test pass rate 80%!!

250 are Breast registered in NC; that’s only 13.6% of all registered sonographers in NC! 

Data as of Fall 2015
## Board Exam Objectives

### Breast (BR) Tasks

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anatomy and physiology</strong></td>
<td>18%</td>
<td>- Normal anatomy and physiology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Distinguish lymph nodes related to the breast</td>
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<td></td>
<td></td>
<td>- Identify age-related sonographic changes of the breast tissue and its components</td>
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<td>- Identify functional units of the breast (e.g., lobes, ducts, etc.)</td>
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<td>- Identify the components comprising each tissue layer of the breast</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Identify the tissue layers within the breast</td>
</tr>
<tr>
<td><strong>Perfusion and function</strong></td>
<td></td>
<td>- Identify normal blood flow patterns within the breast tissue and its components</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Identify the vasculature of the breast</td>
</tr>
<tr>
<td><strong>Pathology</strong></td>
<td>30%</td>
<td>- Abnormal perfusion and function</td>
</tr>
<tr>
<td></td>
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<td>- Assess spectral Doppler tracings of the vasculature related to a mass/lesion</td>
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<td></td>
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<td>- Evaluate lesion vascularity using color Doppler</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Evaluate lesion vascularity using power Doppler</td>
</tr>
<tr>
<td><strong>Benign vs. Suspicious</strong></td>
<td></td>
<td>- Analyze characteristics of infectious processes</td>
</tr>
<tr>
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<td>- Analyze lesions classified by BI-RADS</td>
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<td></td>
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<td>- Analyze lymph node involvement in conjunction with presenting pathology</td>
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<td>- Analyze patterns on surrounding tissues from malignant tumor or inflammatory reactions</td>
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<td>- Analyze the male breast and axilla for disease</td>
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<td>- Correlate specimen sonograms in patients undergoing excisional breast biopsies</td>
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<td>- Evaluate postoperative biopsy site for complications (e.g., seroma, hematoma, etc.)</td>
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<td></td>
<td>- Use sonography to evaluate breast tissue post interventional procedures</td>
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<td></td>
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<td>- Use sonography to evaluate implant integrity</td>
</tr>
</tbody>
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### Board Exam Objectives

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient care</strong></td>
<td>5%</td>
</tr>
<tr>
<td><strong>Communications</strong></td>
<td></td>
</tr>
<tr>
<td>Educate patients about the ultrasound exam</td>
<td></td>
</tr>
<tr>
<td><strong>Integration of data</strong></td>
<td>15%</td>
</tr>
<tr>
<td><strong>Incorporate outside data (Clinical assessment, Health &amp; Physical [H&amp;P], Lab values)</strong></td>
<td></td>
</tr>
<tr>
<td>Apply BI-RADS assessment categories when evaluating breast images</td>
<td></td>
</tr>
<tr>
<td>Apply results/findings of the mammogram to guide scanning of the breast tissue</td>
<td></td>
</tr>
<tr>
<td>Compare suspicious ultrasound findings with mammographic findings</td>
<td></td>
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<tr>
<td>Compare ultrasound findings with MRI results</td>
<td></td>
</tr>
<tr>
<td>Compare ultrasound findings with nuclear medicine study results/findings</td>
<td></td>
</tr>
<tr>
<td>Obtain pertinent clinical history from the patient and/or the medical records</td>
<td></td>
</tr>
<tr>
<td>Use patient's signs and symptoms to help guide ultrasound exam</td>
<td></td>
</tr>
<tr>
<td><strong>Reporting results</strong></td>
<td></td>
</tr>
<tr>
<td>Obtain pathology correlation</td>
<td></td>
</tr>
<tr>
<td><strong>Protocols</strong></td>
<td>4%</td>
</tr>
<tr>
<td><strong>Clinical standards and guidelines</strong></td>
<td></td>
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<tr>
<td>Analyze breast using various scan planes (e.g., longitudinal/transverse, radial/antiradial, etc.)</td>
<td></td>
</tr>
<tr>
<td>Analyze breast using various scan techniques (e.g., scan with palpation, standoff pad, fremitus, etc.)</td>
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</tr>
<tr>
<td>Analyze breast with patient in various positions (e.g., oblique, supine, upright, etc.)</td>
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</tr>
<tr>
<td>Document breast exam using standard imaging protocols (e.g., quadrants, clock face, etc.)</td>
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<tr>
<td><strong>Measurement techniques</strong></td>
<td></td>
</tr>
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</table>
# Board Exam Objectives

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Label images using the distance from the nipple</td>
<td>5%</td>
</tr>
<tr>
<td>Perform various measurements to assess breast anatomy and pathology</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Physics</strong> 9%</td>
<td></td>
</tr>
<tr>
<td><strong>Artifacts</strong></td>
<td></td>
</tr>
<tr>
<td>Identify common artifacts seen on breast ultrasound</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Hemodynamics</strong></td>
<td></td>
</tr>
<tr>
<td>Adjust transducer pressure when using Doppler</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Imaging instruments</strong></td>
<td></td>
</tr>
<tr>
<td>Adjust console settings for optimal imaging results</td>
<td>3%</td>
</tr>
<tr>
<td>Use curvilinear array transducer</td>
<td>3%</td>
</tr>
<tr>
<td>Use linear array transducer</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Treatment</strong> 12%</td>
<td></td>
</tr>
<tr>
<td><strong>Interventional procedures</strong></td>
<td></td>
</tr>
<tr>
<td>Apply real-time ultrasound guidance during procedures</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Intraoperative procedures</strong></td>
<td></td>
</tr>
<tr>
<td>Correlate sonographic findings with sentinel lymph node biopsy</td>
<td>2%</td>
</tr>
<tr>
<td>Maintain infection control</td>
<td>2%</td>
</tr>
<tr>
<td>Use sterile technique when preparing for procedure</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Sonographer role in procedures</strong></td>
<td></td>
</tr>
<tr>
<td>Use sonography to evaluate regional lymph node basins prior to sentinel lymph node biopsy</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Other</strong> 7%</td>
<td></td>
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<tr>
<td><strong>New technologies</strong></td>
<td></td>
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<tr>
<td>Understand the use of brachytherapy in the treatment of breast cancer</td>
<td>1%</td>
</tr>
<tr>
<td>Use 3-D/4-D when evaluating the breast</td>
<td>1%</td>
</tr>
<tr>
<td>Use elastography when evaluating the breast</td>
<td>1%</td>
</tr>
</tbody>
</table>
Did you know...?

Registered mammographers can become registered in Breast Sonography through The American Registry of Radiologic Technologists.
Q. Are sonographers performing breast ultrasound examinations required to have training specific to breast ultrasound?

A. Yes. In order to meet the ACR initial qualifications, technologists performing breast ultrasound exams must have at least 5 continuing education units (CEUs) or (CMEs) of breast ultrasound topics.

B. After they meet these initial qualifications, they must continue with the continuing education as required by the certifying organization (i.e., ARRT, RDMS). For RDMS it is nonspecified credits per triennium.

C. When a sonographer performs the examination, he or she should be qualified by appropriate training to do so. This qualification can be demonstrated by certification or eligibility for certification by a nationally recognized certifying body, such as RDMS or ARRT.
Image labeling should include a permanent identification label that contains:

1. Facility name and location.
2. Examination date.
3. Patient’s first and last name.
4. Identifying number and/or date of birth.
5. Designation of right or left breast.
6. Anatomic location using clock face notation or a labeled diagram of the breast. Transducer orientation and distance from the nipple to the abnormality, if present, are required.
7. Sonographer’s and/or physician’s identification number, initials, or other symbol.
Appropriate indications for breast sonography include, but are not limited to:

1. Evaluation and characterization of palpable masses and other breast related S/S.
2. Evaluation of suspected or apparent abnormalities detected on other imaging studies, such as mammography or MRI.
3. Initial imaging evaluation of palpable masses in women under 30 years of age who are not at high risk for development of breast cancer, and in lactating and pregnant women.
4. Evaluation of problems associated with breast implants.
5. Evaluation of breasts with microcalcifications and/or architectural distortion suspicious for malignancy or highly suggestive of malignancy in a setting of dense fibroglandular tissue, for detecting an underlying mass that may be obscured on the mammogram.
7. Treatment planning for radiation therapy.
8. As a supplement to mammography, screening for occult cancers in certain populations of women (such as those with dense fibroglandular breasts who are also at elevated risk of breast cancer or with newly suspected breast cancer) who are not candidates for MRI or have no easy access to MRI.
9. Identification and biopsy guidance of abnormal axillary lymph node(s), for example in patients with newly diagnosed or recurrent breast cancer or with findings highly suggestive of malignancy or other significant etiology.
How to Image Breast Tissue
Mammogram Vs. Sonogram

- Mammogram is **GOLD** Standard in Breast Imaging
- Breast Ultrasound Screening is NOT standard of care, but is a valuable tool to answer questions the mammogram cannot answer.
- Breast screening is used as a screening tool in cases of dense breast, BDV 3 and BDV 4.
- Breast Ultrasound is first imaging modality in cases of palpable lump in someone under 30 years of age, or a pregnant or lactating female.
Ultrasound IS a Valuable Tool

• The **#1** major targeted indication for breast ultrasound is **PALPABLE ABNORMALLY**

• The **#2** major targeted indication for breast ultrasound is evaluation of a **Mammographic Abnormality**

Bonus: What is the most common benign palpable breast abnormality?
In the United States:
• Breast cancer is the most common cancer among American women after skin cancer.
• 231,840 new cases of invasive breast cancer will be diagnosed in women in 2015.
• 62,570 new cases of breast carcinoma in situ (non-invasive, has not invaded nearby tissue), including ductal carcinoma in situ and lobular carcinoma in situ.
• 40,290 women will die from breast cancer.
• 2,350 new cases of breast cancer will be diagnosed in men.
• 440 men will die from breast cancer.
• The five-year relative survival rate for female invasive breast cancer patients has improved from 75 percent in the mid-1970s to 90 percent today.
• The five-year relative survival rate for women diagnosed with localized breast cancer (cancer that hasn’t spread to lymph nodes or outside the breast) is 98.5 percent. In cancer that has spread to nearby lymph nodes (regional stage) or to distant lymph nodes or organs (distant stage), the survival rate falls to 84 percent or 24 percent, respectively.
• There are more than 2.8 million breast cancer survivors in the U.S., including women still being treated and those who have completed treatment.

According to the American Cancer Society, Cancer Facts & Figures 2015

http://www.bcrfcure.org/breast-cancer-statistics-resources?gclid=CMOm_Lb9ssgCFY8WHzd78gJqDg
The reporting system should be concise and organized using the following structure.

1. Indication for examination
2. Description of the overall breast composition (BDV)
3. Clear description of any important findings
4. Comparison to previous examinations
5. Assessment (BIRADS)
6. Management
The law requires mammography providers to notify women categorized as having dense breast tissue about their condition.

A mammography report example;

"Your mammogram indicates that you may have dense breast tissue. Dense breast tissue is relatively common and is found in more than forty percent (40%) of women. The presence of dense tissue may make it more difficult to detect abnormalities in the breast and may be associated with an increased risk of breast cancer. We are providing this information to raise awareness of this important factor and to encourage you to talk with your physician about this and other breast cancer risk factors. Together, you can decide which screening options are right for you. A report of your results was sent to your physician."

Breast Density Value (BDV 3 or 4)

NC is the 12th state to enact a breast density notification law
Breast Composition Categories

BDV 1 – The Breasts are almost entirely fatty.
  Mass detection is highly sensitive mammographically in a fatty breast.

BDV 2 - There are scattered areas of fibroglandular density.
  Few areas of dense tissue in a fatty breast. <50% dense

BDV 3 - The breasts are heterogeneously dense, which may obscure small masses.
  Mix of dense and fat, with more dense features. >50 % dense

BDV 4 - The breasts are extremely dense, which lowers the sensitivity of mammography.
  The sensitivity of mammography is lowest in this category >75% dense
BDV Categories

Almost entirely fatty
BDV 1

Scattered areas of density <50%
BDV 2

Heterogeneously dense >50%
BDV 3

Extremely Dense >75%
BDV 4

Breast Density Value Classifications
Mammogram AND Sonogram Correlation

BDV 1

BDV 2

BDV 3

BDV 4
What BDV is this???
What BDV is this?
What BDV is this??
# Final Assessment Categories

## BIRADS

<table>
<thead>
<tr>
<th>Category</th>
<th>Management</th>
<th>Likelihood of cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Needs Additional Imaging</td>
<td>Recall for additional imaging</td>
<td>n/a</td>
</tr>
<tr>
<td>1 Negative</td>
<td>Routine Screening</td>
<td>Essentially 0%</td>
</tr>
<tr>
<td>2 Benign</td>
<td>Routine Screening</td>
<td>Essentially 0%</td>
</tr>
<tr>
<td>3 Probably Benign</td>
<td>Short Interval Follow-up (3-6mth)</td>
<td>&gt;0 but &lt; 2%</td>
</tr>
</tbody>
</table>
| 4 Suspicious                          | Tissue Diagnosis                   | *Low  
*Moderate  
*High  
Suspicion for Malignancy |
| 5 Highly Suggestive of Malignancy    | Tissue Diagnosis                   | >95%                          |
| 6 Known Biopsy-Proven                | Surgical Excision When Clinical Appropriate | n/a                           |
BIRADS 1, 2, 3, 4, 5

BIRAD 0 = Needs additional imaging, and BIRADS 6= Confirmed malignancy through biopsy
BIRAD 2 - Benign
BIRAD 5 – Highly Suspicious
Accurate correlation of mammographic and sonographic findings first requires complete diagnostic mammographic work-up and development of an appropriate differential diagnosis before sonographic evaluation.

The mammographic finding should be characterized as a;

- mass
- asymmetry
- architectural distortion
- suspicious calcifications (not usually seen on U/S)
- or a combination of these features

Careful mammographic and sonographic correlation includes;

- location
- size
- shape
- margins
Sonographers that can read and correlate findings with mammograms are AWESOME!!
Review Breast Anatomy

Anatomy of the Breast

The Breast & Chest Wall

 Courtesy of Dr. Green of Stanly Regional Medical
Review Breast Anatomy

Anatomy of the Breast

Lymph Node Drainage

Courtesy of Dr. Green of Stanly Regional Medical
Tissue Types on Mammogram

1. Glandular
2. Fibrous (connective)
3. Adipose

Glandular
Fibrous
Veins (tubeculae)
Adipose

LML
Study:CA
3 Breast Zones

- Premammory Zone: It is the most superficial zone, containing fat and Cooper’s ligaments. Pearl: Set your grayscale to this fat.
- Mammory Zone: Middle zone contains central ducts and most peripheral ducts and lobules. Most breast pathology arises here.
- Retromammory Zone: Over the chest wall, contains mostly fat and ligaments.
3 Breast Zones / Tissue Types On Ultrasound

Skin

PreMammory Zone

Adipose

Fibrous

Glandular

Mammory Zone

Retromammory Zone

11:00

12:00

Left Breast ARad
FAT is the frame of reference against which all echogenicites is compared to. Set up scan parameters such as Total Gain and TGC so that FAT appears to be a midlevel gray. Normal fat should not be demonstrated as hypoechoic. Poor fat settings may lead to missing masses.
**Mammographic Mass Features**

- A 'Mass' is a space occupying 3D lesion seen in two different projections. If a potential mass is seen in only a single projection it should be called a 'asymmetry' until its three-dimensionality is confirmed.

- Shape
- Margins
- Density
Mammographic Mass Shapes

- Oval
- Round
- Irregular
Mammographic Margins
Circumscribed, Obscured, Microlobulated, Indistinct, or Spiculated

**Circumscribed:** Well-defined. This is a benign finding.

**Obscured or partially obscured:** When the margin is hidden by superimposed fibroglandular tissue.

**Microlobulated:** Lobulation implies a suspicious finding.

**Indistinct:** Historically ill-defined. This is also a suspicious finding.

**Spiculated:** Radiating lines from the mass is a very suspicious finding.
Mammographic **Density Levels**
High, Equal, Low Dense Tissue Features

The density of a mass is related to the expected attenuation of an equal volume of fibroglandular tissue. High density is associated with malignancy. It is extremely rare for breast cancer to be low density.

**Bonus:** So how does fat show up on mammogram?
- **Asymmetry** as an area of fibroglandular tissue visible on only one mammographic projection, mostly caused by superimposition of normal breast tissue.
- **Focal asymmetry** visible on two projections, hence a real finding rather than superposition. This has to be differentiated from a mass.
- **Global asymmetry** consisting of an asymmetry over at least one quarter of the breast and is usually a normal variant.
- **Developing asymmetry** new, larger and more conspicuous than on a previous examination.

Mammographic Asymmetry

Asymmetry versus Mass

- All types of asymmetry have different border contours than true masses and also lack the conspicuity of masses.

- Asymmetries appear similar to other discrete areas of fibroglandular tissue except that they are unilateral, with no mirror-image correlate in the opposite breast.

- An asymmetry demonstrates concave outward borders and usually is interspersed with fat, whereas a mass demonstrates convex outward borders and appears denser in the center than at the periphery.

Here an example of a focal asymmetry seen on MLO and CC-view. Local compression views and ultrasound did not show any mass.

The term **Architectural Distortion** is used when the normal architecture is distorted with no definite mass visible. This includes thin straight lines or spiculations radiating from a point, and focal retraction, distortion or straightening at the edges of the parenchyma. The differential diagnosis is scar tissue or carcinoma.

Architectural distortion can also be seen as an associated feature. For instance if there is a mass that causes architectural distortion, the likelihood of malignancy is greater than in the case of a mass without distortion.

This is scar tissue

Mammographic Calcifications

- Not usually seen with ultrasound
- Classified by morphology and distribution
Most DCIS appears as microcalcifications at mammography without a visualized mass. Microcalcifications are seen in this mammo and sonogram clearly. Confirmed DCIS.
Important Associated Features in a Malignant Breast

- Associated features are things that are seen in association with suspicious findings like masses, asymmetries and calcifications.
- Associated features play a role in the final assessment. For instance a BI-RADS 4-mass could get a BI-RADS 5 assessment if seen in association with skin retraction.
- Skin Thickening >2mm
- Nipple Retraction
- Axillary Adenopathy
- Architectural Distortion
- Calcifications
- Edema
<table>
<thead>
<tr>
<th>Mammography Lexicon</th>
<th>Ultrasound Lexicon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breast composition</strong></td>
<td><strong>Breast composition</strong></td>
</tr>
<tr>
<td>A. entirely fatty</td>
<td>a. homogeneous - fat</td>
</tr>
<tr>
<td>B. scattered areas of fibroglandular density</td>
<td>b. homogeneous - fibroglandular</td>
</tr>
<tr>
<td>C. heterogeneously dense, which may obscure masses</td>
<td>c. heterogeneous</td>
</tr>
<tr>
<td>D. extremely dense, which lowers sensitivity</td>
<td></td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td><strong>Shape</strong></td>
</tr>
<tr>
<td>shape</td>
<td>oval - round - irregular</td>
</tr>
<tr>
<td>margin</td>
<td>Circumscribed or Not-circumscribed: indistinct, angular, microlobulated, spiculated</td>
</tr>
<tr>
<td>density</td>
<td>parallel - not parallel</td>
</tr>
<tr>
<td><strong>Asymmetry</strong></td>
<td><strong>Echo pattern</strong></td>
</tr>
<tr>
<td>asymmetry - global - focal - developing</td>
<td>anechoic - hyperechoic - complex cystic/solid</td>
</tr>
<tr>
<td><strong>Architectural distortion</strong></td>
<td>hypoechoic - isoechoic - heterogeneous</td>
</tr>
<tr>
<td>distorted parenchyma with no visible mass</td>
<td>posterior features</td>
</tr>
<tr>
<td>no features - enhancement - shadowing - combined pattern</td>
<td></td>
</tr>
<tr>
<td><strong>Calcifications</strong></td>
<td><strong>Associated features</strong></td>
</tr>
<tr>
<td>morphology</td>
<td>architectural distortion - duct changes - skin thickening - skin retraction - edema - vascularity (absent, internal, rim) - elasticity</td>
</tr>
<tr>
<td>suspicious</td>
<td>in mass - outside mass - intraductal</td>
</tr>
<tr>
<td>1. amorphous</td>
<td>simple cyst - clustered microcysts - complicated cyst - mass in or on skin</td>
</tr>
<tr>
<td>2. coarse heterogeneous</td>
<td>foreign body (including implants) - intramammary lymph node - AVM - Mondor disease - postsurgical fluid collection - fat necrosis</td>
</tr>
<tr>
<td>3. fine pleomorphic</td>
<td></td>
</tr>
<tr>
<td>4. fine linear or fine linear branching</td>
<td></td>
</tr>
<tr>
<td>distribution</td>
<td></td>
</tr>
<tr>
<td>diffuse - regional - grouped - linear - segmental</td>
<td></td>
</tr>
</tbody>
</table>
The BI-RADS categories include:

- Size
- Shape
- Orientation
- Margins
- Echogenicity
- Lesion Boundary Features
- Posterior Artifact Features
- Vascularity
- Surrounding Tissue Features

Bonus: What is likely the most important mass feature in this list to image very well?
Mass Margins

- Circumscribed
- Indistinct
- Angular
- Microlobulated
- Spiculated
Mass Margins

Circumscribed:
A margin that is well defined or sharp, with an abrupt transition between the lesion and surrounding tissue.

Not Circumscribed:
The mass has one or more of the following features:

- Indistinct:
  No clear demarcation between a mass and its surrounding tissue.

- Angular:
  Some or all of the margin has sharp corners, often forming acute angles.
Mass Margins

**Not Circumscribed:**
The mass has one or more of the following features, continued:

**Microlobulated:**
Short cycle undulations impart a scalloped appearance to the margin of the mass.

**Spiculated:**
Margin is formed or characterized by sharp lines projecting from the mass.
• **Round** –
  Spherical, ball-shaped, circular, or globular

• **Oval** –
  Elliptical or egg-shaped (may include 2-3 undulations)

• **Irregular** –
  Neither round or oval
Mass Echogenicities

- Anechoic
- Hyperechoic
- Hypoechoic
- Mixed
- Isoechoic
- Complex cystic/solid
- Heterogeneous
• Apply minimal pressure to avoid small vessel compression
• PRF between 700-1.000Hz
• Low Wall Filter
• Maximize Color Gain
• Do not angle color box
• Power Doppler Angio is good option for detecting slow non angle dependent flow
• Make sure your color box is not too big, it slow frame rate, and lowers sensitivity
• Use light transducer pressure as a heavy hand can compress the vessels
Significance of Orientation

• Invasive nature of cancer to be able to invade through fascial tissue planes. This growth upward is always suspicious.

• Mass growth contained within its fascial plane is horizontal and a more benign orientation.
Neoplasm Spicules Crossing Tissue Planes
Desmoplastic Reaction

Lesion Boundary

- Tissue reaction and attempt to contain neoplasm
- Appears as a hyperechoic halo
Thin Walled Abrupt Well-Circumscribed Lesion Boundary
Surrounding Tissue Features

Take into account the surrounding tissue density when comparing sonographic and mammographic structures;

• A lesion that is completely fat surrounded on mammograms should be completely fat surrounded at sonography.
• A lesion that appears to be completely surrounded by water density tissue on mammography should be surrounded by hyperechoic fibrous or isoechoic glandular tissue sonographically.
Surrounding Tissue Features
Where is this mass?
I’m right here!

What kind of tissue surrounds this mass? Correlate mammo to U/S.
• Helps to identify the margins of a lesion
• Helps to distinguish malignant from benign tumors
• Cancer - vibrations conducted along tumor infiltration into center, hence color pixels run into center of tumor and fill it in
• Benign lesions - cannot get power Doppler into center of lesion
Posterior Artifact Features

Enhancement and Shadowing
Posterior features represent the attenuation characteristics of a mass with respect to its acoustic transmission. Usually cysts and Fibroadenomas exhibit enhancement and malignant masses usually exhibit posterior shadowing.
Sonographer’s Impression:

- Round, Well-Circumscribed, Anechoic, Posterior Enhancement, Cystic, Nonvascular
- Oval, Well-Circumscribed, Wider than Tall, Anechoic, Posterior Enhancement, Cystic
- Irregular, Not Well-Circumscribed, Microlobulated, Hypoechoic, Solid
- Irregular, Angular Margins, Solid, Posterior Shadowing, Taller than Wide
- Solid, Irregular, Spiculated, Hypoechoic, Echogenic Halo, Posterior Shadowing, Vascularized

Tech Initials
Is this Dense Breast Tissue or Malignant Mass? How would you describe this palpable mass?
Size: Mammogram to Sonogram
How to measure correctly

The capsule surrounding a mass is a water density, indistinguishable from mass mammographically so you should always include the capsule (outer to outer) when measuring. BUT, measure masses the same way they were on priors in order to accurately monitor size over time.

Measure in the longest axis, and place second set of calipers exactly 90’ to that measurement. Then turn transducer 90’ for transverse measurement.
MRI and Mammography are the more exact method of mass size estimation, with sonography showing some underestimation in size.

Mammograms show water densities as a summation of parenchyma and pathology.

As a result, the mass measurement on the mammogram may appear larger, but should be no more than 20% larger compared to U/S.
Measure a Spiculated Mass

- Do not include spicules or thick rim of surrounding echogenic desmoplasia in your measurement.
Measure a Cyst

- Measure the longest axis of the lesion and the second measurement is at its right angle,
- Then turn the transducer 90 degrees for the transverse measurement
**Measure a Lymph Node**

- Measure cortical thickness of the lymph node.
- Abnormal lymph nodes become round and mass-like, with increased cortical thickening and loss of fatty hilum.
- Measure the longest length, its 90 degree angle, and then the transverse.

[Images showing normal and abnormal lymph nodes with arrows indicating measurements.]

[Online resource link provided for further information.]
Mammo CC view correlates closely with Sonographic transverse.

Mammographic lobulations and contour should correspond to the same lobulations and contour sonographically, though surrounding tissue may cause contour variability.

Apparent differences in shape between the mammogram and sonogram can be due to rotation of the lesion. Mammographic compression and sonographic compression place difference between rotational forces on breast structures. Mammographic compression pulls tissue away from the chest wall and rotates the long axis of a lesion perpendicular to the chest wall. Sonographic compression, on the other hand, pushes tissue planes toward the chest wall, and rotates the long axis of lesions parallel to the chest wall.
Technical Consideration:
Mammo to Sono Mass Orientation Changes

**Mammogram**
Pulling away from chest wall

**Ultrasound**
Compression onto chest wall
<table>
<thead>
<tr>
<th>Mammography Lexicon</th>
<th>Ultrasound Lexicon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breast composition</strong></td>
<td><strong>Breast composition</strong></td>
</tr>
<tr>
<td>A. entirely fatty</td>
<td>a. homogeneous - fat</td>
</tr>
<tr>
<td>B. scattered areas of fibroglandular density</td>
<td>b. homogeneous - fibroglandular</td>
</tr>
<tr>
<td>C. heterogeneously dense, which may obscure masses</td>
<td>c. heterogeneous</td>
</tr>
<tr>
<td>D. extremely dense, which lowers sensitivity</td>
<td><strong>Shape</strong></td>
</tr>
<tr>
<td></td>
<td>oval - round - irregular</td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td><strong>Margin</strong></td>
</tr>
<tr>
<td>shape</td>
<td>Circumscribed or Not-circumscribed:</td>
</tr>
<tr>
<td></td>
<td>indistinct, angular, microlobulated, spiculated</td>
</tr>
<tr>
<td>margin</td>
<td><strong>Orientation</strong></td>
</tr>
<tr>
<td>circumscribed - obscured - microlobulated - indistinct - spiculated</td>
<td>parallel - not parallel</td>
</tr>
<tr>
<td>density</td>
<td><strong>Echo pattern</strong></td>
</tr>
<tr>
<td>fat - low - equal - high</td>
<td>anechoic - hyperechoic - complex cystic/solid</td>
</tr>
<tr>
<td></td>
<td>hypoechoic - isoechoic - heterogeneous</td>
</tr>
<tr>
<td><strong>Asymmetry</strong></td>
<td><strong>Posterior features</strong></td>
</tr>
<tr>
<td>asymmetry - global - focal - developing</td>
<td>no features - enhancement - shadowing - combined pattern</td>
</tr>
<tr>
<td><strong>Architectural distortion</strong></td>
<td><strong>Calcifications</strong></td>
</tr>
<tr>
<td>distorted parenchyma with no visible mass</td>
<td>in mass - outside mass - intraductal</td>
</tr>
<tr>
<td><strong>Calcifications</strong></td>
<td><strong>Associated features</strong></td>
</tr>
<tr>
<td>morphology</td>
<td>architectural distortion - duct changes - skin thickening - skin retraction - edema - vascularity (absent, internal, rim) - elasticity</td>
</tr>
<tr>
<td>suspicious</td>
<td>special cases</td>
</tr>
<tr>
<td>typically benign</td>
<td>simple cyst - clustered microcysts - complicated cyst - mass in or on skin - foreign body (including implants) - intramammary lymph node - AVM - Mondor disease - postsurgical fluid collection - fat necrosis</td>
</tr>
<tr>
<td></td>
<td><strong>Special cases</strong></td>
</tr>
<tr>
<td></td>
<td>(cases with a unique diagnosis)</td>
</tr>
<tr>
<td>distribution</td>
<td></td>
</tr>
<tr>
<td>diffuse - regional - grouped - linear - segmental</td>
<td></td>
</tr>
<tr>
<td><strong>Associated features</strong></td>
<td></td>
</tr>
<tr>
<td>skin retraction - nipple retraction - skin thickening - trabecular thickening - axillary adenopathy - architectural distortion - calcifications</td>
<td></td>
</tr>
</tbody>
</table>
“Know your lumps”

Mammogram of a patient with multiple bilateral palpable lumps, mostly circumscribed masses stable over years. A new palpable lump is found. Mammogram shows spiculated mass and is confirmed to be IDC.

Know your lumps! A new lump in a lumpy breast is a concern.

Image Source: http://www.ultrasound.theclinics.com/article/S1556-858X(06)00070-3/fulltext
• When scanning **Lateral** breast tissue, always put patient up obliquely and have them raise their arm up. This flattens the tissues and significantly improves image quality.

• When scanning **Medial** breast tissue, supine with arms by their side is appropriate.
“How long did you scan the breast?”

Take an image immediately to start time, then begin your breast survey and imaging.
Palpable Lump Imaging

Always palpate for lumps!
Assumptions can be dangerous. Do not assume that there is only one mass there. As you see here, this patient had a cyst and a solid mass concurrently. The sonographer imaged the cyst and thought this represented the mammographic abnormality. In a short term follow-up it was discovered that the patient had a rapid increase in size of a malignant mass missed on the sonogram. A good policy is to identify what you think is the mammographic mass and survey the rest of the quadrant for any additional findings.

http://www.ultrasound.theclinics.com/article/S1556-858X(06)00070-3/fulltext
Ipsilateral Axilla

• Image ipsilateral axilla in all patients with a suspicious mass.

• This axillary node was an incidental finding.
Axillary Lymphadenopathy

This is why you should always image the axilla in patients with suspicious breast mass. You want to know if the cancer has spread yet to the lymph nodes.
Cooper’s Ligaments interspersed in breast tissue may cause shadowing very similar in appearance to spiculated lesions. To determine if these shadows are a true lesion do the following:

- Apply transducer pressure, flattening the ligaments into an axis nearly parallel with the skin and transducer face. Sufficient pressure usually eradicates artifactual shadowing.
- Turn 90 degrees on it. You cannot lose a true mass, but will see a loss in artifactual shadows.
- Look closely at other areas of the glandular breast. Get a sense of just how much glandular distribution there is. There is little chance that all of the suspicious shadowing seen scattered throughout the breast is actually cancer.
- Look at prior studies for any changes.
- Obtain a good patient history. Is anything newly palpable or painful?
Radial Transducer Flip
< at 1:00 and 7:00 >

Where should my notch be?

Notch up at 12:00

Notch left at 7:00

Notch up at 6:00

Notch left at 1:00

One of the most frequently asked student questions
This compression move puts the ducts more parallel to the transducer face and perpendicular to the sound beam which improves the ductal image quality.
Adequate sonographic characterization of superficial lesions is facilitated by use of a glob of gel or a standoff pad so that the lesion is at least 5 to 7 mm away from the face of the transducer; even with current 12- to 15-MHz linear array transducers, the beam cannot be optimally focused more anteriorly.
Superficial “Foreign Body” Imaging

Note the gel bed standoff for superficial imaging.

OWWIE !!
How can you improve this image?
How can you improve this image?
Use of Intrinsic Landmark

- Breast calcification
- Nipple
- Chest Wall
- Known other mass
- Scar
- Tissue Characteristics (area of dense tissue)
Intrinsic Landmarks: Use something in the breast to help identify the location of new mass

Breast Calcification is our landmark here
Intrinsic Landmark: Nipple
BREAST MASS LOCALIZATION

Quadrants ~ Hemispheres ~ Clock-Face ~ Triangulation
Central Breast- 12:00 or 6:00 or Retroareola

Lateral

Medial
Central Breast - 12:00 or 6:00 or Retroareola

Medial

Lateral
Time Correlation in CC Views

Rcc

---9:00---

-----10:00 or 8:00 --------

-----11:00 or 7:00 --------

-----12:00 or 6:00 --------

-----1:00 or 5:00--------

-----2:00 or 4:00----

-----3:00----

Lcc

---3:00---

-----2:00 or 4:00 -----

-----1:00 or 5:00-------

-----12:00 or 6:00 ------

-----11:00 or 7:00 -------

-----10:00 or 8:00 --------

-----9:00-----
TIME CORRELATION IN MLO VIEW

Rt
- Medial
- Lateral

Lt
- MEDIAL
- LATERAL

12:00
11:00 OR 1:00
10:00 OR 2:00
9:00 OR 3:00
8:00 OR 4:00
7:00 OR 5:00
6:00
Clock-Face Locations

R

9:00  12:00  3:00  6:00

N

L

9:00  12:00  3:00  6:00

N
Clock-Face Wedges

Right Breast

Left Breast
Measuring Distance

- Anterior lesions on mammography should be within the anterior third of the tissue on ultrasound, closer to the skin surface than the chest wall.
- Posterior lesions close to the chest wall on both mammographic views should be close to the pectoral muscle on ultrasound.
- The distance along the skin surface from the center of the lesion to the nipple in centimeters should be shown on the ultrasound images. Have a ruler for lesions that are too far out of transducer’s field of view.
- The transducer itself can be used as a guide to estimate mass size, mine at 6 cm.
- Measure and remember your own finger length and use for distance.
Lesion Localization using ABC 123

Measuring Distance and Depth

- The numbers 1, 2, 3 define equal-width rings extending from the areolar margin to the periphery of the breast. The ring labeled 1 is most central, and 3 is most peripheral.

- The depth description includes A, B, C. These letters divide the breast into equal thirds in depth. The A zone is most superficial whereas the C zone is the deepest third.

- Measure Distance from Nipple
- Indicate Mass depth using 1/3’s
When a lesion is seen in only one view of mammo, it may be necessary to scan an entire hemisphere.
Standard Mammography Views

The acquisition

Radiographic views of the breast

Standard views:
- 45° Medio lateral Oblique (MLO view) / Lundgren’s view
- Craniocaudal view (CC view)

The film

Google Images
The craniocaudal (CC) view is the other standard view used in every screening exam. A technically adequate CC view will include as much breast tissue as possible. If you measure straight back from the nipple, the value you get should be within 1 cm of measuring the posterior nipple line on the MLO view. Additionally, make sure that there is not any motion artifact/blurring on any of the mammographic views.

The mediolateral oblique (MLO) view is one of the standard views obtained during every screening exam. The MLO view allows visualization of the largest amount of breast tissue. A technically adequate exam has the nipple in profile, allows visualization of the inframammary fold and includes the pectoralis muscle extending down to the posterior nipple line (an oblique line drawn straight back from the nipple.)

The lateral view is an additional view obtained at virtually every diagnostic evaluation. A lateral view may be obtained as a mediolateral (ML) or lateralmedial (LM) view depending on where the imaging tube and detector are located. For an ML view, the tube emitting the x-ray is medial and the detector plate is lateral. The ML view is best for lesions located in the central or lateral breast. For the LM view, the tube is lateral, the detector medial and it is best for evaluating medial lesions. Lateral views are extremely useful in determining the exact location of an abnormality in the breast.
Location is more predictable in CC view as the MLO angle varies 30-60 degrees.

A lesion that lies along the PNL on a mammo MLO view (appearing to lie near 3 or 9) may actually lie several cm superior to or inferior to the 3 or 9 positions at sono.

The degree of movement superiorly or inferiorly is greatest for peripherally located lesions and lesser for centrally located lesions.

A wider wedge of tissue may be necessary to find lesions in the far lateral or medial location. Often, scanning can be directed over the lesions located near 12 or 6 on the CC mammo view, but scanning all the way from the 1-5 positions may be necessary to find lesions that project near 3 or 9 on the MLO mammo view.
Central Breast Mass seen on CC only

Scan 12 and 6 in 30 Degree Wedges
Central Breast Mass seen on MLO only
Scan 9:00 and 3:00 in 90 Degree Wedges

MLO view has more variability in its location requiring larger wedge
If the lesion is visible only on the MLO view, a true mediolateral (ML) view should be obtained. The position of the difficult to find lesion should be compared on the true ML and MLO films by placing the ML and MLO views side by side (mediolateral on the right and MLO on the left) with the nipple at the same level on both views. If the nodule lies higher on the ML view than on the MLO view, it usually lies medially. Because the beam passes from high medial to low lateral on the MLO view medial lesions project lower than their true location on the MLO view. Thus, the medially located nodule will generally project higher on the true mediolateral view than it will on the MLO view. Conversely, if the nodule projects higher on the MLO view than on the true mediolateral view, it is usually located in the lateral half of the breast. If the CC view is placed next to the MLO view with the nipple at the same level, an arrow drawn through the nodule from the mediolateral to MLO view will usually point to the half of the breast in which the nodule lies.

“medial muffins rise”

“lateral lead falls”

Stavros Breast Ultrasound Chapter 6
Triangulating Breast Masses

With the nipple aligned across views and the MLO view in the center, the location of a mass visible in only two of the three mammographic projections can be inferred by triangulation.

<table>
<thead>
<tr>
<th>TRIANGULATING LESIONS USING THE ML, MLO AND CC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where lesions will move between the ML and MLO dependent on if they are medial or lateral.</td>
</tr>
<tr>
<td>• In general, lateral lesions will move DOWN on the ML relative to the MLO</td>
</tr>
<tr>
<td>• In general, medial lesions will move up on the ML relative to the MLO</td>
</tr>
<tr>
<td>• Line the nipples up with the images in the following order to project where you would expect to see a lesion on a projection</td>
</tr>
</tbody>
</table>

ML relative to the MLO is what we look at
Triangulating: Medial Breast Mass

Mass appears slightly higher in the ML view therefore this mass is confirmed to be medial.

“medial muffins rise”
Triangulating: Central Breast Mass

TRIANGULATING LESIONS USING THE ML, MLO AND CC

Where lesions will move between the ML and MLO dependent on if they are medial or lateral.

- In general, lateral lesions will move DOWN on the ML relative to the MLO
- In general, medial lesions will move up on the ML relative to the MLO
- Line the nipples up with the images in the following order to project where you would expect to see a lesion on a projection

[Diagram of breast with lines connecting ML, MLO, and CC views with stars indicating lesion location]
Mammographic Mass Location Practice
Triangulating: Lateral Mass
Where is This Mass?

“lateral lead falls”
This mass is at 10:00
Where is this Mass?
Ultrasound correlation: Rt breast 4:00, 3 cm from nipple
Where am I?
Here I am!

I’m at 12:00!

- A: 398.36mm²
- P: 71.74mm
- M: 451.87 US
- SD: 116.33 US
Where am I?
Here I am!

Right Retroareolar, slight to 3:00
Where am I??
Here I am!
1. Where am I?

Lt CC

Lt MLO
1. Here I am!

Lt CC

Lt MLO

Left breast mass at 4:00
2. Where am I?

Lt CC

Lt MLO
Left breast mass at 11:00
3. Where am I?

Rt CC

Rt MLO
3. Here I am!

Rt CC

Rt MLO

Right breast retroareolar mass
4. Where am I?

Rt CC

Rt MLO
Right breast mass at 10:00
5. Where am I?

Rt CC

Rt MLO
5. Here I am!

Rt CC

Right breast mass at 6:00

Rt MLO
What do you see?

What do you think the report will say?
Educational Resources

5. http://www.bcrfcure.org/breast-cancer-statistics-resources?gclid=CMOm_Lb9ssgCFY8WHwodz8gJDg
7. https://www.google.com
8. Breast Ultrasound by Thomas Stavros
9. Dr. Green of Stanly Regional Medical