BREAST ULTRASOUND
ACR BI-RADS®

UNC Breast Imaging Division
July 2018
Overview

This module is to educate residents on
• ACR BI-RADS® Atlas 2nd edition Ultrasound
• Sonomammographic anatomy
• Sonographic features most associated with malignancy
• Clinical and sonographic features of common diseases
• ABR Core Exam Ultrasound blueprint & study guide
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ACR BI-RADS®

- ACR Breast Imaging Reporting and Data System
- Developed in 1993 by ACR to improve the reporting of mammograms
- BI-RADS®- Mammography Fifth Edition 2013
ACR BI-RADS® Ultrasound second ed. 2013

I. General Considerations
II. Breast Imaging Lexicon - Ultrasound
III. Reporting System
IV. Guidance

APPENDIX: ACR BI-RADS® - Ultrasound Lexicon Classification Form
I. General Considerations - Anatomy
II. Breast Imaging Lexicon - Ultrasound
III. Reporting System
IV. Guidance

APPENDIX: ACR BI-RADS® - Ultrasound Lexicon Classification Form
Breast Anatomy

- Fat and fibroglandular tissue of the breast between superficial fascia and pectoral fascia
- 7-8 to 20 lobes with associated duct segments
- Duct at nipple then arborizes until most peripheral duct = intralobular terminal duct end in TDLU
- Vascular lateral thoracic, internal mammary bv
- Lymphatics 90% to ipsilateral axilla
Breast Anatomy 1:1 Correlation

- Skin
- Subdermal fat
- Dense parenchyma
- Pectoral muscle

RIGHT BREAST
10 O’CLOCK
ANTIRADIAL
Breast Anatomy 1:1 Correlation

(Rotate 90 degree for comparable viewing)
Breast Anatomy 1:1 Correlation

* Absence of subdermal fat with extremely dense parenchyma
Gynecomastia

- Enlargement of the male breast due to subareolar duct and stroma proliferation
- Typically present with subareolar mass tenderness
- Unilateral or asymmetric in 72%
- No associated breast cancer risk
- Subareolar with concentric distribution
- Nodular, dendritic, diffuse
- Hormonal effects of medications (anti-hypertensives, antidepressants, H2 blockers, illicit drugs), endocrine-active tumor
* Classic flame-shaped retroareolar density. Beware the appearance of gynecomastia on US (irregular and spiculated) as a CA mimicker!
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Ultrasound Breast Imaging Lexicon

A. Tissue composition *screening only*
B. Masses
C. Calcifications
D. Associated features
E. Special cases
Tissue Composition* screening only

- Homogeneous background echotexture - Fat
- Homogeneous background echotexture - Fibroglandular
- Heterogeneous background echotexture
  a. can be either focal or diffuse
  b. multiple areas of incr and decr echogenicity
  c. shadowing at fat/parenchyma interfaces
  d. younger breasts and HD parenchyma
Tissue Composition Examples

Fat Composition: Homogeneous on US

Dense Composition: Homogeneous on US
Scattered Fibroglandular Densities: Heterogeneous on US
Ultrasound Breast Imaging Lexicon

A. Tissue composition
B. **Masses**
C. Calcifications
D. Associated features
E. Special cases

**Mass** is space occupying seen in 2 projections and characterized as to:

- Shape
- Orientation
- Margin
- Echo pattern
- Posterior acoustic features
Ultrasound Breast Imaging Lexicon

A. Tissue composition
B. Masses
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E. Special cases

Mass Lexicon

- Shape: oval, round, irregular
- Orientation: parallel, not parallel
- Margin: circumscribed, not circumscribed (indistinct, angular, microlobulated, spiculated)
- Echo pattern: anechoic, hyperechoic, complex cystic and solid, hypoechoic, isoechoic, heterogeneous
- Posterior acoustic features: no posterior features, enhancement, shadowing, combined pattern

Lexicon Pictorial Commences . . .
NB: Normal Structures Elongate

Rib in transverse and longitudinal planes

Distinguish a true mass via scanning in > 2 projections and its appearance at real time scan
Masses: Shape **oval, round, irregular**

- **Oval**
  - Macrolobulated is subtype of oval with 2-3 gentle undulations

- **Round**
  - Round is sphere

- **Irregular**
  - Irregular not oval or round
Masses: Orientation parallel, not parallel

Orientation is a feature unique to US

Parallel vs not parallel to the skin surface

Not parallel is ‘taller than wide’
Masses: Margin *circumscribed, not circumscribed*

**Circumscribed**

Circumscribed mass margin is well-defined with abrupt transition.

**Not Circumscribed**

Not circumscribed mass margin is defined by its descriptors: indistinct, angular, microlobulated, spiculated.
Masses: Margin not circumscribed descriptors

Indistinct has no clear demarcation
Angular has sharp corners often acute angles
Microlobulated is scalloped
Spiculated has projecting sharp lines
Masses: Echo Pattern anechoic, hyperechoic, complex
cystic and solid, isoechoic, hypoechoic, heterogeneous

Anechoic shown is cyst with simple fluid

Hyperechoic shown is lipoma

Complex cystic and solid contains both anechoic and
echogenic tissue (BI-RADS 4 as 25% are malignant as in this
case papilloma with DCIS)

Isoechoic is relative to fat, acute hematoma in this case
Hypoechoic masses are both CA

Heterogeneous is a mixture of echogenic patterns within a solid mass, often due to CA as in this case.
Masses: Posterior Acoustic Features no, enhancement, shadowing, combined

Posterior acoustic feature is the acoustic transmission of a mass i.e., the attenuation characteristics of the mass.

Enhancement is echogenic.
A. Tissue composition
B. Masses
C. **Calcifications**
D. Associated features
E. Special cases

**Calcifications** characterized as:

- In a mass
- Outside of a mass
- Intraductal
Calcifications in a mass

43yo F with left breast mass

39yo F with left breast mass
Calcifications outside of a mass

- Fine linear and fine linear branching calcifications
- Right breast mass
Calcifications intraductal

fine pleomorphic calcifications
Ultrasound Breast Imaging Lexicon

A. Tissue composition
B. Masses
C. Calcifications

D. Associated features

E. Special cases

Associated features Lexicon

- Architectural distortion
- Duct change
- Skin changes:  
  a. skin thickening 
  b. skin retraction
- Edema
- Vascularity:  
  a. absent 
  b. internal vascularity 
  c. vessels in rim
- Elasticity assessment  
  a. soft 
  b. intermediate 
  c. hard
Ultrasound Breast Imaging Lexicon

A. Tissue composition
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Special cases Lexicon
- Simple cyst
- Clustered microcysts
- Complicated cyst
- Mass in or on skin
- Foreign body including implant
- Lymph node - intramammary
- Lymph node - axillary
- Vascular abnormalities - a. AVMs
  b. Mondor disease
- Postsurgical fluid collection
- Fat necrosis

NB: Pictorial for Associated features and Special cases slides #43-58...
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ACR BI-RADS® Atlas

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ACR BI-RADS® Atlas

- Quality assurance tool
- Facilitates outcomes monitoring
- Standardized lexicon improves clarity of thought
- Standardized lexicon improves pt care by reducing ambiguity in reports
- Establishes framework for breast imaging reports
- BIRADS #0-6 with 1 2 3 4 5 and 6 as final category designations and 0 as an incomplete category
ACR BI-RADS® Assessment Categories

- CATEGORY 0: INCOMPLETE - NEED ADDITIONAL IMAGING EVALUATION AND/OR PRIOR MAMMOGRAMS FOR COMPARISON
- CATEGORY 1: NEGATIVE
- CATEGORY 2: BENIGN
- CATEGORY 3: PROBABLY BENIGN
- CATEGORY 4: SUSPICIOUS
- CATEGORY 5: HIGHLY SUGGESTIVE OF MALIGNANCY
- CATEGORY 6: KNOWN BIOPSY-PROVEN MALIGNANCY
ACR BI-RADS® Management Recommendations

- **Category 0: INCOMPLETE - NEED ADDITIONAL IMAGING EVALUATION AND/OR PRIOR MAMMOGRAMS FOR COMPARISON**
  Recall for additional imaging and/or comparison with prior examinations
- **Category 1: NEGATIVE (0% risk)**
  Routine mammography screening
- **Category 2: BENIGN (0% risk)**
  Routine mammography screening
- **Category 3: PROBABLY BENIGN (<2% risk)**
  Short interval 6 month follow-up OR continued surveillance
- **Category 4: SUSPICIOUS (2-95% risk)**
  Biopsy should be performed in the absence of clinical contraindications
- **Category 5: HIGHLY SUGGESTIVE OF MALIGNANCY (>95% risk)**
  Biopsy should be performed in the absence of clinical contraindications
- **Category 6: KNOWN BIOPSY-PROVEN MALIGNANCY (100% risk)**
  Surgical excision when clinically appropriate
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Ultrasound Features of Malignancy

- Irregular (round) **shape**
- Not parallel **orientation**
- Not circumscribed (indistinct, angular, microlobulated, spiculated) **margins**
- Hypoechoic, isoechoic, complex cystic and solid, and heterogeneous **echogenicity**
- No, shadowing, or combined **posterior acoustic features**
- Architectural distortion, skin thickening, skin retraction, edema **associated features**
Ultrasound Features of Benignity

- Oval shape
- Parallel orientation
- Circumscribed margins
- Anechoic, Hyperechoic echogenicity
- Enhanced or no posterior acoustic features
Illustrating BI-RADS® Cases

- **Category 5: HIGHLY SUGGESTIVE OF MALIGNANCY (>95% risk)**
  Biopsy should be performed in the absence of clinical contraindications

  - 71yo F with screen-detected left breast mass: irregular and spiculated
  - 56yo F with high risk screen-detected right breast mass: irregular not parallel and microlobulated
  - 87yo F with screen-detected right breast mass: irregular not parallel and spiculated
Illustrating BI-RADS® US Lexicon

- Architectural distortion, skin thickening and skin retraction

81yo F with right breast mass and skin retraction
Illustrating BI-RADS® US Lexicon

- Skin retraction

40yo F with left breast mass
Illustrating BI-RADS® US Lexicon

- Edema

49yo F with right breast mass
Occur in 10% of all women

• May be palpable, painful, grow/regress quickly
• Anechoic mass, imperceptible wall, posterior enhancement
• Painful cysts can be aspirated under ultrasound - benign type
  - fluid yellow, green

**Remember: Special cases Lexicon**

- Simple cyst
- Clustered microcysts
- Complicated cyst
- Mass in or on skin
- Foreign body including implant
- Lymph node - intramammary
- Lymph node - axillary
- Vascular abnormalities - a. AVMs
  b. Mondor disease
- Postsurgical fluid collection
- Fat necrosis

**Special cases**

- Those with pathognomonic appearance
Simple Cyst

- Occur in 10% of all women
- May be palpable, painful, grow/regress quickly
- Anechoic mass, imperceptible wall, posterior enhancement
- Painful cysts can be aspirated under ultrasound - benign type fluid yellow, green
Clustered Microcysts

- Etiologies include fibrocystic change and apocrine metaplasia
- Lesion consists of cluster of tiny anechoic foci, individually smaller than 3 mm
- Thin intervening septations and no discrete solid component
- B-R 3 vs B-R 2 lesion
Complicated Cyst

- Homogeneous low level internal echoes
- May have a layered appearance
- Fluid-debris levels may shift with pt position
- May also contain brightly echogenic foci that scintillate as they shift
- NOT complex cystic and solid mass
Mass in Skin: Epidermal Inclusion Cyst

- Arise in hair follicle
- Spontaneous or prior trauma
- Dermal locale, punctum on skin, skin tract on US
- When inflammed, accompanying edema, hypervascularity, and erythema ensues
- Visual inspection
- Utility of US - skin tract and claw sign
Mass in Skin: Metastasis

86yo F history treated ovarian CA now presenting w dermal mass and peau d'orange
Mass in Skin: Metastasis

43yoF midcycle breast CA neoadjuvant therapy with right ‘mastitis’
62yoF prior implants, DCIS, skin-sparing mastectomy with breast mass

Classic snowstorm of silicone
Lymph Node

- Common finding in axilla and breast
- Distinctive benign appearance: circumscribed oval masses often reniform, contain hilar fat
- Hypoechoic cortex, echogenic hilum < 2-3cm
- Pathologic appearance: cortex focally or diffusely thickened
- DDx metastatic disease, lymphoma/leukemia, CTD, granulomatous disease, reactive

LN varying appearances, clockwise from top left:
- Normal intramammary
- Normal axillary
- Metastases in eccentric enlarged cortex
- Diffuse metastatic involvement
- LN replaced by tumor
<table>
<thead>
<tr>
<th>BI-RADS® 4</th>
<th>BI-RADS® 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unilateral</td>
<td></td>
</tr>
<tr>
<td>• DDx breast carcinoma, metastatic melanoma, ovarian CA, other CA</td>
<td></td>
</tr>
<tr>
<td>• Careful eval ipsilateral breast</td>
<td></td>
</tr>
<tr>
<td>• Bilateral axillary US to determine if uni/bilateral</td>
<td></td>
</tr>
<tr>
<td>• Clinical eval to exclude mastitis, breast abscess, skin infx, cat scratch fever</td>
<td></td>
</tr>
<tr>
<td>• Proceed to FNA or CNB</td>
<td></td>
</tr>
<tr>
<td>• Bilateral</td>
<td></td>
</tr>
<tr>
<td>• Frequently reactive in inflammatory ds and HIV</td>
<td></td>
</tr>
<tr>
<td>• Sarcoid, SLE, psoriasis, analogous ds</td>
<td></td>
</tr>
<tr>
<td>• Known dx Lymphoma - add wording “known lymphoma”</td>
<td></td>
</tr>
<tr>
<td>• When bilateral LN new or increasing - rethink BI-RADS® 4 and include pass for flow cytometry (saline or RPMI)</td>
<td></td>
</tr>
</tbody>
</table>
Postoperative Fluid Collection

- Postoperative seroma
- May be entirely cystic
- May contain (mobile) blood products
- Comparison with pt history and with prior exams crucial
- BI-RADS® Category 2

42yoF with history of treated breast cancer with left breast mass
Fat Necrosis

- Benign condition
- Trauma-induced but patient may have no knowledge of precipitating event
- Typically presents as palpable mass
- Oil cyst
- Occasionally - irregular mass that merits CNB
Mondor Disease

- Pathology
  - Sclerosing thrombophlebitis of subcutaneous veins of anterior chest wall
  - Fibromuscular hyperplasia of vessel wall
- Clinical Presentation
  - Typical age 30-60yo
  - Painful breast with cord-like mass
- Visual Inspection
  - Upper outer quadrant
  - Sudden appearance of red, tender, firm band accompanied by skin retraction
  - CBE findings accentuated by raising arm
- Imaging Findings
  - Superficial tubular beaded vein on imaging
  - May be seen on mammo and ultrasound
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Most common breast mass in patients <35 yo
- Contain stromal tissue and breast ductules
- Sensitive to hormone changes eg pregnancy
- Oval parallel circumscribed hypoechoic
- May contain calcifications
- Biopsy is recommended for newly palpable or increasing in size or demonstrating suspicious features on exam
Phyllodes

- Histologically similar to fibroadenoma
- Typically present as rapidly enlarging mass
- Appearance is similar to (large) fibroadenoma
- May be complex and contain cystic spaces
- 10% malignant - no distinguishing features
- Excision of benign and malignant phyllodes
- Recurrence local. Rare lung, bone, liver mets
Papilloma

- May be solitary or multiple
- Solitary - subareolar, multiple - peripheral
- Classically bloody nipple discharge, also clear
- Round or oval hypoechoic masses, intraductal, calcifications
- Atypia on CNB merits excision
Lipoma

- Common asymptomatic breast masses
- May present as unilateral palpable soft mass
- Oval circumscribed homogeneous, hypoechoic, isoechoic, hyperechoic masses
- Mature lipocytes with at least a thin capsule
Hematoma

- Antecedent trauma
- Anticoagulated or bleeding diathesis
- Mass or bruise
- Mixed echogenicity mass(es)
- May have skin involvement
- Improvement on follow up
Mass in Pregnant\&Lactating Patient

**DDx**

1. (FA)
2. (Cyst)
3. Lactating adenoma
4. Galactocele
5. Puerperal mastitis / abscess
6. Pregnancy-associated breast cancer (PABC)

**ULTRASOUND**

- Modality of choice in these women
- Non ionizing
- Non invasive
- Easy to perform
- Cost effective
- Majority of lesions are benign and those that aren’t typically follow rules ie BI-RADS Ultrasound
Mastitis

- Common etiologies: lactation, post trauma
- Pain, erythema, edema, mass
- US study of choice for diagnosis and surveillance
- Breast parenchyma hyperechoic, hypervascular, skin edema, reactive lymphadenopathy
- Delayed or inadequate antibiotic treatment can progress to abscess
Puerperal Abscess

- Progression of mastitis most common etiology
- Delayed or inadequate antibiotic treatment
- Staph aureus in nursing woman
- Pain, erythema, edema, mass
- US study of choice for diagnosis and IR guidance
- Round or irregular complex mass, fluid-debris levels or mobile debris
- US surveillance
Galactocele

- Benign mass with milk contents
- Results from obstructed milk duct
- During and following cessation of lactation
- Most regress over time
- Aspiration can be diagnostic and therapeutic
- Oval or round, variable internal echogenicity
- Fat-fluid level
Lactating Adenoma

- Variant of fibroadenoma, tubular adenoma, or lobular hyperplasia as benign stromal tumors
- Third trimester through lactation
- Natural course is regression following cessation of breast feeding
- Oval or lobulated
Pregnancy Associated Breast Cancer

- Pregnancy Associated Breast Cancer
- PABC defined as breast cancer found during pregnancy or in the first year following
- 1 in 3000 pregnancies complicated by breast CA
- Increasing incidence
- 50% are high grade and 80% are lymph node +
- Poorer prognosis including recurrence < 3yrs
- 90% present with palpable mass
- US appearance mass virtually same as nongravid pt
Though Cyst and FA are still commonly encountered consider the 4 DDx unique to pregnant and lactating patient

- Unique clinical presentations with little overlap

- **Puerperal Abscess** inflammatory sx early postpartum
- **Lactating Adenoma** present like FA as painless, soft, mobile masses. They may also become infarcted and present atypically as a firm tender mass. Unique feature of LA is the tendency to occur earlier then regress after cessation of breast-feeding
- **Galactocele** tendency to occur near cessation of breast-feeding
- **PABC** defined as breast cancer found during pregnancy or in the first year following. Increasing incidence due to US maternal demographics. 50% are high grade and 80% are lymph node +. Poorer prognosis including recurrence < 3yrs. 90% present with palpable mass
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i) Sonomammographic anatomy
ii) Cyst versus solid mass
iii) Mastitis/abscess
iv) Characterization of cysts
v) Lymph node characterization
   (1) Axillary (2) Supraclavicular (3) Intramammary
vi) Characterization of solid masses
   (1) Benign versus malignant
      (a) Cyst
      (b) Fibroadenoma
      (c) Hamartoma
      (d) Abscess
      (e) Hematoma
      (f) Phyllodes tumor
      (g) Ductal/lobular carcinoma
      (h) Carcinoma in situ
      (i) Metastasis
      (j) Lymphoma
      (k) Inflammatory carcinoma
vii) Architectural distortion
viii) Intraductal masses/abnormalities, galactocele
ix) Screening
x) Multifocal/centric malignancy
xi) Elastography
xii) Role of IV contrast

Breast (10-15%) Relevant and appropriate Diagnostic Ultrasonographic applications and findings in the entities listed in the Breast section of this blueprint

- a. Normal sonomammographic anatomy
- b. Cystic versus solid mass
- c. Mastitis/abscess
- d. Characterization of cysts
- e. Lymph node characterization: axillary, supraclavicular, intramammary
- f. Characterization of solid masses: benign vs. malignant
- g. Architectural distortion
- h. Intraductal masses/abnormalities
- i. Galactocele
- j. Ultrasound Screening
- k. Multifocal malignancy
ABR Core Exam Study Guide: Breast and Ultrasound

Think back and test yourself