**BI-RADS Lexicon: 2012**

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**Conflict of Interest Disclosure**

- No real or apparent conflicts of interest to disclose.

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**BI-RADS**

Breast Imaging Reporting and Data System

- ACR Quality assurance tool to:
  - standardize breast imaging reporting
  - terminology
  - assessment categories
  - recommendations

- 2012:
  - new 5th ed for Mammography
  - new 2nd ed for Breast Ultrasound
  - new 2nd ed for Breast MRI

**Why Should We Use BI-RADS?**

- More consistency among radiologists/reporting
- Improves communication with referring clinicians
- Correct Term → Correct Diagnosis
  - eg: “Fine, linear, branching califications”
  - eg: “Irregular, spiculated mass with rim enhancement and washout” → BIRADS 5

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**Objective**

- Highlight anticipated major changes to BI-RADS lexicon in 2012
  - Official BIRADS 2012 pending
- Review how BIRADS terms determine appropriate work-up
  - Not intended as comprehensive review of all BI-RADS lexicon and reporting structure to date, beyond scope/timeframe of this talk

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**BI-RADS Assessment Categories**

**Classification:**

0 - Incomplete
1 - Negative
2 - DEFINITELY Benign
3 – PROBABLY Benign
4 – Suspicious
5 – Highly suspicious
6 – Known Malignancy prior to excision

**Management:**

0. Need additional Imaging
1. Routine screening
2. Routine screening
3. Short interval followup
4. Biopsy
5. Biopsy
6. Treat
  eg: Receiving preop neoadjuvant chemotherapy for LABC*  

*LABC = Locally advanced breast cancer (i.e. > 5 cm, skin and/or chest wall involvement, inflammatory cb, metastatic lymadenopathy)
BI-RADS 3 – Probably Benign
Short-term Interval followup
(<2% probability of malignancy)
• Never use off screening mammogram
  • i.e. do diagnostic work-up first
• NOT newly palpable lesions
  • i.e. not BI if growing/new
• NOT BRCA carriers
  • Since Cancers look like FAs in them
  Eg.
  - Circumscribed, oval mass
  - Grouped punctate or round calcs
  - Non-palp, focal asymmetry with neg US
  - Complicated i.e. low-level echoes cyst* (vs. FNA)
  Vs. COMPLEX Cyst
  (mixed solid/cystic component, intracystic mass, thick walls/septations
  → Core biopsy)

BI-RADS 4 – Suspicious
Biopsy Should be considered
(2-95% probability of malignancy)
For intra-institutional/interdepartmental audit purposes (i.e. to let pathologist know of degree of suspicion, can subcategorize:
• 4A (low concern): (2-10%), eg. probable FA, complicated cyst
• 4B (intermed): (11-50%), eg. amorphous, coarse heterog calcs, angular mass
• 4C (moderate): (50-95%), eg. Irreg mass, pleomorphic calcs

BI-RADS 5 – Highly Suspicious
Appropriate Action should be taken
(>95% probability of malignancy)
• i.e. If core biopsy comes back with rad-path discordance, recommend repeat bx (then surgical excision)

Background Breast Tissue Composition

BI-RADS 2012: Update
• Emphasis on
  Background Breast Tissue Composition
  – In all Modalities (Mammo, US, MRI)
  – Provides a context in which evaluating the breast
  – Affects sensitivity?

Background Breast Tissue Composition

– Mammography
  – Almost entirely fat (<25%), scattered fibroglandular (25-50%), Heterogeneously dense (50-75%), Extremely dense (>75%)

– Ultrasound
  – Homogenous vs. Heterogeneous

– MRI
  – No/Minimal (<25%), Mild (25-50%), Moderate (50-75%), Marked (>75%) background parenchymal enhancement

BI-RADS: Ultrasound
BI-RADS 2012: Ultrasound

- Background Echotexture
  - i.e. Tissue composition
- Masses
  - Shape
  - Orientation
  - Margin (incl. Lesion boundary)
  - Echogenicity
  - Posterior Acoustic Shadowing/Enhancement
- Calcifications
- Associated features
  - e.g. Architectural distortion, Vascularity axillary lymphadenopathy

Background Echotexture

- Tissue Composition
  - Homogeneous
    - Uniform hypoechoic fat lobules with echogenic Cooper’s ligaments
    - Uniform echogenic fibroglandular tissue underlying thin subcutaneous fat
  - Heterogeneous
    - Focally or Diffusely variable in echotexture, with many areas of increased/decreased echogenicity

Background Echotexture

Homogeneous

- Fat
  - Uniform hypoechoic fat lobules with echogenic Cooper’s ligaments
- Fibroglandular
  - Uniform echogenic fibroglandular tissue underlying thin subcutaneous fat

Background Echotexture

Heterogeneous

- Focally or Diffusely variable in echotexture, with many areas of increased/decreased echogenicity
- Decreased Sensitivity?

Heterogeneous Background Echotexture

Decreased Sensitivity?

Case e.g. Palpable left upper breast lump, Initial mammogram negative

“No definite evidence of a mass or suspicious sonographic abnormality.”

Associated MRI

Large area (3.5 cm) of Left upper breast
Asymmetric, Regional, Clumped NME with washout
Second Look Ultrasound

Infiltrating ductal carcinoma with lobular features

BIRADS 2012: Ultrasound

- Mass
  - Occupies space and should be seen in 2 projections
  - Use Real-time scanning to distinguish from normal anatomy (e.g., Rib, fat lobule)

- "Big 3": SHAPE, MARGINS, ORIENTATION
  - Shadowing, Calcifications, Associated features

- Final BI-RADS assessment category:
  - Choose most worrisome feature
  - Increased # of suspicious features → more likely BI-RADS5
    - e.g., Irregular shape, non-circumscribed margins, anti-parallel orientation, echogenic halo, posterior acoustic shadowing

Masses

- Shape
  - Oval (now includes macrolobulated)*
    - Round
    - Irregular
- Margins
  - Circumscribed vs.
    - Non-circumscribed (everything else; more suspicious)*
      - Indistinct, Membranous, Angular, Speculated
      - Includes Echogenic Rim/Halo* (i.e., lesion-tissue interface)
- Orientation
  - Parallel to skin ("wider-than-tall"; 22% malignant)
  - Anti-parallel ("taller-than-wide"; more suspicious, 70% malignant)
*Anticipated 2012 changes

Shape - Oval

- Egg-shaped, elliptical
- More likely benign (85% benign; bx if new, growing/change)
*2012: includes macrolobulated (2-3 gentle lobulations)

Macrolobulated vs. Microlobulated

- Macrolobulated, a subset of OVAL SHAPE
- 2-3 gentle lobulations
- Less useful descriptor than OVAL shape, CIRCUMSCRIBED margin, and more easily confused with microlobulated

- Microlobulated, type of NON-CIRCUMSCRIBED MARGIN
- 1-2 mm, more numerous, closer together

Shape - Round

- More suspicious than oval
**Shape - Irregular**

- Most suspicious shape (60% malignant), neither oval or round

**Margins**

- Circumscribed
  - More likely benign (10% malignant)

- Non-circumscribed
  - Indistinct (45% malignant)
  - Microlobulated (50% malignant)
  - Angular (60% malignant)
  - Spiculated (85% malignant)
  - Echogenic halo/rim (70% malignant)
  - E.g. in cancer, abscesses, fat necrosis
  - No sharp demarcation between mass & surrounding tissue
  - 2012: mention when considering Margins - Non-circumscribed

**Orientation**

- Parallel to skin
  (i.e. “wider-than-tall”)
  - More likely benign (77% benign) growing along tissue planes

- Anti-parallel
  (i.e. “taller-than-wide”)
  - More suspicious
  (70% malignant) growing against tissue planes

**BI-RADS Ultrasound: 2012 Update Summary**

- Tissue Composition
  - Homogenous vs. heterogeneous

- Shape
  - “Macrolobulated” now incorporated into OVAL

- Margins
  - Circumscribed vs. Noncircumscribed (everything else), e.g. Indistinct, microlobulated, angular, spiculated

- Echogenic Rim/Halo
  - Now incorporated into Margins – Non-circumscribed
**BI-RADS: Mammography**

- Mass
  - SHAPE (oval, round, irregular)
  - MARGIN (circumscribed, obscured, indistinct, microlobulated, spiculated)
  - Density (fat-containing*, low, equal, high density)

- Architectural Distortion
- Calcifications

*fat-containing masses are benign (rare-engulfed fat by IDC), do not need to US. may lead to unnecessary bx, eg. Hamartoma, lactating adenoma/galactocele

**Calcifications**

(for your reference)

- Morphology
  - Typically benign
    - Eg. Skin, vascular, coarse/popcorn, large rod-like, round, lucent-centered, rim, milk-of-calcium, suture, dystrophic
  - Round/Punctate (unless increasing/new, then suspicious)
  - Intermediate
    - Amorphous, indistinct., coarse heterog.
  - High Suspicion
    - Fine pleomorphic
    - Fine linear/branching (biopsy even if stable)

- Distribution
  - Grouped (clustered)*
  - Linear
  - Segmental
  - Regional
  - Scattered/Diffuse

* Sickles et al have reported removal of “clustered” from BI-RADS lexicon, since synonymous with “grouped” (although this is not certain, since 2012 publication not yet released)

**BI-RADS 2012: Mammography**

- Mass - SHAPE
  - Round
  - Oval (*lobular expected to be removed in 2012, for consistency with US BIRADS)
  - Irregular

**Masses & Asymmetries**

- space-occupying lesion seen
  - on 2 views, with convex outward borders
  - Old terminology: “nodular density”, “nodule”
BI-RADS: Focal Asymmetry

- Space-occupying lesion seen
  - On 2 views, < a quadrant, and lacking borders/mass-like quality
  - i.e. concave borders, interspersed fat
  - old terminology="asymmetric density"
  - (On screening mammogram, 0.9% prevalence with 0.7% malignant)

- more concerning if:
  - palpable, associated calcifications, architectural distortion, lymphadenopathy

BI-RADS: Asymmetry

- “Potential mass” seen
  - On only 1 of the 2 views
  - old terminology= "density”, which could be confused with lesion density
    (i.e. “fat-containing”, “high density”)
  - (prevalence 3.3%, 1.8% malignant;
    83% caused by Summation artifact/27% “real lesions")

BI-RADS: Global Asymmetry

- Asymmetry relative to contralateral breast
  - > a quadrant
  - not associated with a mass, calcifications, or architectural distortion
  - old terminology= "asymmetric breast tissue"
  - (3.3% prevalence with 1.3% malignant*)

- usually not significant unless Palpable abnormality or New
  - In which case, US & bx

BI-RADS: Developing Asymmetry

- 2012 update:
  - Increased prominence of a Focal Asymmetry
    (new, larger, or denser), warranting work-up
    - (prevalence 0.2% with 23-27% malignant; i.e. BI-RADS 4 lesion)
    - R/O Interval hormones? Trauma? Surgery? Infection?

2011 screening CC  
2012 screening CC  
2011 MLO  
2012 MLO


Denser, slightly larger than prior year
Developing Asymmetry

On spot CC & MLO compressions views – the developing asymmetry persists. Correlating with a small, irregular, spiculated mass on US, which demonstrates an echogenic halo and heavy posterior shadowing.

Developing Asymmetry

• Another eg

2010 mammograms read as
"Heterogeneously Dense Breasts. Negative - BI-RADS1"

Developing Asymmetry

Patient returns one year later with a RUQ palpable lump, correlating with a developing asymmetry, with suspected architectural distortion

Developing Asymmetry

BI-RADS Mammography: 2012 Update Summary

• "Developing Asymmetry"
  – 2012: Increased prominence of a Focal Asymmetry
  – (new, larger, or denser), warranting work-up (13-27% malignant, i.e. BI-RADS 4 lesion)

• Mass
  – Shape
    • Oval, Round (more concerning than oval), Irregular
  – 2012: Anticipate "lobular" will be removed (i.e. part of Oval), to be consistent with US BIRADS descriptors
  – Margins:
    • Circumscribed
    • Noncircumscribed (Microlobulated, obscured, indistinct, spiculated)

• Calcifications
  – 2012: Anticipate "clustered" will be replaced with "grouped" (≥5 calcs/1cc

BI-RADS: MRI
BI-RADS MRI: 2012 Update Summary

- **Protocol:** **Bilateral** breast scanning
  - Easier to compare symmetry of background parenchymal enhancement;
  - Less likely to miss DCIS
- **Protocol:** Include T2-weighted non-contrast sequence
- **Need fuel weighting**
- **Evaluate Kinetics**
- **Background parenchymal enhancement** description
- **2012:** Removed “stippled/punctate”, “reticular/dendritic”, “ductal” descriptors of NME, enhanced internal septations, central enhancement.
- Should have **MR biopsy** available if doing diagnostic MRI
- **Combined reporting** (correlating mammography, ultrasound, and MRI results)

BI-RADS MRI Report

- **Clinical Indication**
- **Technique**
  - Dedicated breast coil, T1 or T2 non-fat sat. type of fat-suppression, contrast injection/IV, timing of DCE, Post-processing (subtraction, MRI reconstructions)
- **Prior Comparison Exams**
- **Background parenchymal enhancement**
- **Findings**
  - Breast findings (lesion Location, Morphology, Kinetics)
  - Associated findings (Chest wall, Skin, Nipple, Edema, Cysts)
  - Axillary & Internal Mammary LN evaluation
- **Non-Breast findings** (Mediastinum, Abdomen)
- **Impression:**
  - BI-RADS Assessment and Category: Recommendations
  - “2012: emphasizes Assessment should be based on combined interpretation of correlating mammography, US, and/or MRI workup
  - Eq. Even if MRI ‘negative’, but there is a suspicious ultrasound mass, recommend US-guided bx and BI-RADS 4 or 5.

BI-RADS MRI Lexicon

- **Descriptors:**
  - Morphology
  - Distribution
  - Kinetics
  - 1’-2 min: Slow, Medium, Rapid
  - After 1’-2 min (or after curve begins to change: Persistent, Plateau, Washout
  - Can use MRI-CAD software or manual ROIs to det washout
- **MORPHOLOGY trumps “CURVOLOGY”**
  - Lesion Morphology better predictor of malignancy than Kinetics

DCE-MRI Kinetics Curve Assessment

- **Type 1 – Persistent** (5-9% malignant)
- **Type 2 – Plateau** (6-64%)
- **Type 3 Curve – Washout** (33-85% malignant)
- **Rapid rise is assoc with malignancy**

DCE-MRI: Kinetics Analysis

- **Clinical indication:** “LABC” (no outside US/mammo images initially available at time of MRI interpretation)
- **T2-Intensity, non-diffusion restricting mass with washout, obscured by marked bilateral symmetric background parenchymal enhancement**

Assessing for Washout visually & manually with ROIs

- **Subtracted DCE MRI** @ 2 min
- **DCE MRI** @ 4 min
- **DCE MRI** @ 8 min

9/21/2012
Irregular-shaped, irregularly-marginated mass with washout. Easy to miss in the context of moderate background parenchymal enhancement.

Background Parenchymal Enhancement

- Similar to mammography reporting, which includes background tissue composition, to inform of context in which reading the exam
- Normal fibroglandular tissue enhances, often in a "stippled" pattern (tiny dots, separated by normal tissue, with this fibroglandular NME sometimes confluent)
- Minimizes tendency to overdiagnose NME/BPE
  - i.e. inadvertent BI-RADS of normal tissue and/or fibrocystic change
  - Eg. "diffuse stippled enhancement" or "regional diffuse stippled enhancement" = NORMAL FIBROGLANDULAR TISSUE or FCC
  - Therefore, removed stippled from BI-RADS lexicon, usually not pathologic
- BIRADS 3 reserved for UNIQUE findings superimposed on background parenchymal enhancement

Background Parenchymal Enhancement

- Indicates metabolically-active tissue, susceptible to normal cycle variation (thus, MRI preferred when BPE minimized days 7–14/2nd wk)
- Odds of Breast cancer increases with degree of BPE
- not necessarily correlates with mammogram breast density (increases) Hormonal Use, Pregnancy/Radiation
  (Decreases) Chemotherapy (Arimidex, Femara, Tamoxifen), Radiation, menopause
- None
- Minimal (<25%)
- Mild (25-50%)
- Moderate (50-75%)
- Marked (>75%)
- "Minimal and Marked Background Parenchymal enhancement can obscure invasive and non-invasive cancer"

BI-RADS MRI Lexicon

- Is there a lesion that "stands out/is unique" among the background parenchymal enhancement? ...Is it a:
  - Mass ≥ 5 mm
    - Description: Mass
      - Nearly always malignant if symmetric, High T2 correlate, Stable
      - Eg. Background parenchymal enhancement, FCC, LN
      - Vs.
      - Is: UNIQUE, no T2 correlate, and/or NEW?
      - IF NOT, NON-definitely benign (i.e. B3, B4 or B5)
  - Non-mass like enhancement
    - Eg. DCIS, ILC, Normal tissue, focal Atelectasis, FCC, Inflammation

Normal fibroglandular tissue:
Minimal (<25%) background parenchymal enhancement
(has relatively symmetric "stippled" foci throughout both breasts)

Minimal (<25%) Mild (25-50%) Moderate (50-75%) Marked (>75%)
**T2-bright, tiny foci of enhancement scattered bilaterally**

- Benign and/or physiologic

Foci with high T2 correlate have 100% NPV for malignancy

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**Mass**

3-D space-occupying lesion that comprises one process

- **Shape**
  - Oval (PPV 5-19%), Round (PPV 10%), Lobulated (PPV 8%)
  - Irregular (PPV 16-41%)

- **Margin (highest PPV for malignancy)**
  - Smooth (NPV 5%, except in high-risk, eg. BRCA+)
  - Irregular (PPV 20-100%), Spiculated (PPV 33%)

- **Internal enhancement**
  - Homogenous (PPV 14-36%), heterogenous (PPV 22-43%)
  - rim enhancement (PPV 41%), dark internal septations (NPV 99%, eg. FA)

- 2012: BI-RADS Removed: enhancing internal septations, central enhancement (since now widely used)


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**Mass - Oval or Round shape, Smooth-margin**

Oval, partially smooth, partially spiculated margins with heterogeneous and thick rim enhancement and central necrosis/non-enhancement, with spicules extending into the surrounding tissue & skin with skin enhancement

Round & Oval Smooth Masses with homogenous enhancement

**Mass - Irregular**

**Mass - Spiculated**

**Mass - Spiculated**

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ILC and IDC
Mass - Homogeneous & Heterogeneous Enhancement

Fibroadenoma

Mass – Non-enhancing internal septation

Non-enhancing septations
Have high NPV (98%)
I.e. most likely benign

Post-treatment breast s/p lumpectomy: incidental fibroadenoma

Mass - Rim Enhancement

Cyst wall enhancement, fibrocystic change

Mass - Rim Enhancement

Fat necrosis

Intracystic, Papilloma

Mass - Rim Enhancement

Rim enhancement with irregular/ spiculated margin PPV 80-100%

Non-Mass-like Enhancement

- **Distribution**
  - Focal (1 quadrant, interspersed fat, PPV 11%)
  - Linear, Linear branching (PPV 30-43% for DCIS, ADH, LCIS)
  - Segmental (triangular/cone-shaped towards nipple, PPV 10-100%)
  - Regional (large volume, NOT conforming to a duct, PPV 4%)
  - Multiple regions, diffuse

- **Internal Enhancement Pattern**
  - Homogeneous (PPV 7%)
  - Heterogeneous (PPV 8%)
  - Clumped (“cobblestone”); “grapes”; “string of pearls if in a line”; 30-43% PPV for DCIS

- Symmetry (NPV 100%)

- (Kinetics less important for NME than Masses; may indicate high-grade DCIS if suspicious “curvology” e.g. Washout, seen in only 50% of DCIS)

Sclerosing adenosis

- Focal

- Linear

- Segmental

- Clumped

- Regional

Normal tissue, background parenchymal enhancement

Invasive lobular carcinoma

Focal Fibrocystic Change

Focal Fibrocystic Change (FCC), Incidental Retrospectoral Breast Implants

2012: Ductal NME removed (subset of Linear)
At least 2 large volumes of tissue (not in ductal distribution) separated by normal tissue
DDX-Normal, multicentric carcinoma

NME – Multiple Regions of clumped enhancement

NME - Diffuse
Widely scattered uniform enhancement of breast.
Usually benign proliferative changes.
May be seen with multicentric IDC, ILC

DCIS and IDC

NME - Diffuse

NME - Diffuse

Apocrine DCIS Gr3/3
Summary – BI-RADS Lexicon: 2012

• Changes to all modalities:
  – Mammography:
    • “Developing asymmetry”, “grouped” (clustered) calcifications
    • Mass: interval change, no “lobular” shape
  – Ultrasound:
    • Background tissue composition, no “macrolobulated” shape
      (now absorbed into “Oval”), Echogenic Rim/Halo now a Non-lobular margin descriptors
  – MRI:
    • Background parenchymal enhancement, removed “stippled/punctate”, “reticular/dendritic”, “ductal”, “central” and “internal enhancing septations” from lexicon
    • Scan bilaterally, incl T2 non-contrast sequence
  – BI-RADS Report Assessment to correlate all modalities