BREAST SONOGRAPHY

Instrumentation
- Logistical and Technical Considerations
- Sonographic Breast Anatomy
- Fibrocystic Change
- Characterization of Cystic Masses
- Characterization of Solid Masses
- Reporting
- Summary

INSTRUMENTATION
- Transducer
  - Linear
- Frequency
  - >10 mHz
- Dynamic Range
  - >50 db
- Spatial Compounding and Tissue Harmonics
  - Especially at higher dynamic range

LOGISTICAL AND TECHNICAL CONSIDERATIONS
- Screening vs Diagnostic – ACRIN 6666
- Technical
  - Targeting
  - Correlation
  - Documentation
  - Scan planes
  - Patient position
  - Gain / TGC
  - Transducer manipulation
  - Doppler
  - Special Circumstances
- Artifacts
- Spatial Compounding and Tissue Harmonics
- Emerging Technology

SCREENING VS DIAGNOSTIC
- DIAGNOSTIC
  - Most breast sonography is performed as a targeted evaluation to further explain a focal mammographic or clinical abnormality
- SCREENING
  - Remains controversial primarily because of operator dependency and logistics...
  - ACRIN 6666

DR. JOHN HUFF HAS NO FINANCIAL RELATIONSHIPS TO DISCLOSE

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ACRIN 6666

- JAMA, 5-14-08 – Vol 299, No.18
- 2809 women with heterogeneously or extremely dense tissue in at least one quadrant
- Participants classified as high risk based on various parameters
- Examination performed directly by experienced breast imagers with additional special training for exam criteria
- Median time of exam: 19 minutes
- Compared Screening mammography alone to screening mammography plus screening breast sonography; later addition of MRI

ACRIN 6666 RESULTS & UPDATE

- Addition of screening US to screening mammography (M+US) increased the diagnostic yield with an average of about 4.3 additional cancers per 1000 women screened
- This increased yield remains constant at year 3 of the study

ACRIN 6666 RESULTS & UPDATE

- Initial PPV for biopsy recommendation based on US alone was 8.9% (compared to 22.6% for mammography alone)
- PPV for US increased in year 3 but remained about half of that for mammography alone

ACRIN 6666 CONCLUSIONS

Adding screening US to mammography in high risk women with dense breast tissue:
- Yields an additional average of 4.3 cancers per 1000 women screened
- Substantially increases the number of false positive biopsy recommendations

UNRESOLVED ISSUES

- Physician time / Reimbursement
  - Can results be duplicated with technologist performed exams and shorter time for exams
  - Whole breast US
- PPV
  - Current PPV’s would be regarded as unacceptably low for mammography; attendant cost of false positive biopsy recommendations
- Probably benign criteria
  - Determination of, and logistics for follow-up
- Frequency of screening
- Role of US screening vs MRM screening
**ACR / SBI STATEMENT**

"The American College of Radiology (ACR) and the Society of Breast Imaging (SBI) feel that the results of ACRN 6666 increase the evidence base for the utility and limitations of screening ultrasound. ACRN 6666 established standardized technique and interpretive criteria as well as experience requirements for physicians performing these examinations. At centers which follow similar practice, US may improve detection of early breast cancer in women at increased risk of breast cancer who are not currently recommended for MRI. These results do not justify the recommendation for screening ultrasound for the general public or in lieu of or in addition to MRI for very high-risk women."

**BOTTOM LINE**

- Screening breast sonography should be used very judiciously
- Limit to centers that adopt the rigorous ACRN 6666 criteria for training and performance or have similar experience
- Selected population (high risk / increased density)
- Commitment to scan time
- Understanding of poor reimbursement
- Acceptance of poor PPV for biopsy
- Does not replace mammography
- For now, MRM may be more practical and effective for this patient population

**TARGETING OF EXAM**

- **Clinical**
  - Palpate: If the exam is being performed for a palpable abnormality, palpate the finding before placing the transducer on the patient
  - Confirm that an US finding corresponds to the palpable finding
- **Mammographic**
  - Predict location based on mammographic position
  - MULD
  - Predict US coordinates before US performance
  - Predict US appearance based on size and relationship of mammographic abnormality to anatomic landmarks
  - Is it in premammary or retromammary fat; is it in the glandular tissue; is it at the junction of identifiable anatomic structures?

**ULTRASOUND COORDINATES**

- **Position** should be determined in 3 planes:
  - Radial
    - This is almost universally done with clock face position
  - Distance from nipple
    - Can be done with distance from the nipple or with concentric zones from nipple (e.g. RA, 1, 2, or 3)
  - Depth
    - Superficial, mid or deep (e.g. A, B, C)
- **Document** finding with images in 2 planes and measurements in 3 planes

**SCAN PLANES**

- Axial or Transverse
- Longitudinal or Sagittal
- Radial and antiradial
  - duct orientation
  - Alter as needed
    - Look at all of the lesion as well as its margins

**PATIENT POSITION**

- To correlate with other modalities, begin supine with breast evenly falling on chest wall
  - Locate anticipated US coordinates from other imaging studies in this position
- Modify patient position for improved scanning
  - e.g. For lesions in the UOQ of the breast, role patient away from you to thin out the tissue overlying the area of interest
- For palpable lesions, modify position as needed to reproduce palpable finding
GAIN AND TGC

- The reference tissue in the breast is fat
  - Overall gain should be adjusted with fat medium gray
- TGC is adjusted for uniform echogenicity throughout the depth of tissue
  - Hyperechoic implies more echogenic than fat
  - Hypoechoic implies less echogenic than fat

FOCAL ZONE AND FRAME RATE

- Appropriately adjust focal zone
- As frame rate is less important than in some other applications, one can use wider focal zones without significant compromise

TRANSDUCER MANIPULATION

- Rocking
  - Reduce edge shadowing
  - Improve margin assessment
- Angling
  - Project area of interest free of overlapping structures (e.g. nipple)
- Rotating
  - Orientation
  - Relation to adjacent structures
  - Follow ducts
- Pressure
  - Increase
    - Enhance capsule
    - Reduce artificial shadowing (you can decrease real shadowing too)
  - Decrease
    - Enhance flow

DOPPLER

- Technique
  - Power
  - Transducer pressure
- Solid vs cystic
  - Only useful if flow identified
- Characterization of solid masses
  - Poor predictive value

SPECIAL CIRCUMSTANCES

- **Superficial**
  - Gel or standoff
- **Deep**
  - Lower frequencies
  - Artifact
- **Retroareolar**
  - Gel
  - Angle from side and change orientation
  - “Two hand” technique
- **Fremitus**
  - Experiment

ARTIFACTS

Improved resolution and wider dynamic range produce significant artifacts in breast sonography

- **Tissue harmonics**
  - Reduces artificial echoes by detecting harmonic frequencies and separating them from the fundamental frequency and associated artifacts
- **Spatial compounding**
  - Reduces artificial echoes by generating multiple sound beams across the transducer face
EMERGING TECHNOLOGY

- **Elastography**
  - Technique for mapping relative tissue stiffness in response to an applied force
  - Techniques for breast:
    - Vibration sonoelastography – Use of external or internal sources of vibration (respiration/heart) to produce tissue deformation
    - Compression sonoelastography – Use of mechanical compression to produce deformation
  - Criteria for assessment:
    - Size
    - Stiffness

SIZE

- No change in size of benign fibroadenoma
  
  Image Courtesy Philips

- Malignant mass showing larger on the elastogram
  
  Image Courtesy Philips
STIFFNESS

- Dark blue depicts the stiffest areas in this image
- A=Malignant mass; B=Benign mass

Image Courtesy Philips

UNRESOLVED ISSUES

- Lack of established standards for performance and assessment
- Operator dependency and Inter/Intra-observer variability
- Role in relation to standard sonographic assessment criteria

BOTTOM LINE

- Primary application remains investigational
- Routine clinical application will require additional validation with prospective trials

Sonographic Breast Anatomy

- Skin
- Ducts
- Premammary Fat
- Anterior Mammary Fascia
- Glandular Tissue
- Posterior Mammary Fascia
- Cooper's Ligaments
- Retromammary Fat
- Muscle
- Rib
- Pleura

ANATOMY
LARGE DUCTS

SMALL DUCTS / TDLU’S

FIBROCYSTIC CHANGE

FIBROCYSTIC CHANGE

CYSTIC MASSES

- Simple
- Complicated
- Complex
- Clustered Microcysts
- Dermal

SIMPLE CYSTS

- Circumscribed
- Posterior Acoustic Enhancement
- Anechoic
- Thin Avascular Septations
SIMPLE CYST

THIN SMOOTH WALL
ANECHOIC
SOUND TRANSMISSION

MANAGEMENT OF SIMPLE CYSTS

- No further diagnostic evaluation
- Aspirate
  - If symptomatic
  - If interference with other evaluation
  - Significant incidence of recurrence

COMPLICATED CYSTS

- Circumscribed
- Posterior Acoustic Enhancement
- Low Level Internal Echoes

COMPLICATED CYST

THIN SMOOTH WALL
INTERNAL ECHOES
SOUND TRANSMISSION
INTERNAL ECHOES

GALACTOCELE

MOVING INTERNAL ECHOES

STANDS

6/30/2011
MANAGEMENT OF COMPLICATED CYSTS

- Correlation with other modalities
  - Stable mammographic finding - dismiss
  - Benign cyst on MRM - dismiss
- Single or different from others
  - Aspirate vs follow
- Multiple; none dominant or different
  - Depends on setting and risk
- Symptomatic
  - Aspirate

COMPLEX CYSTIC MASS

- Any mass with both cystic and solid components
  - Mural nodule
  - Eccentric wall thickening
  - Indistinct margins or involvement of surrounding structures
- Terminology often used for complicated cysts but implication very different
- Significant risk of neoplasia

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TERMINOLOGY OF COMPLICATED CYSTS

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CLUSTERED MICROCYSTS

- Look for thinly walled hypo- to anechoic microcysts
- Minimal fibrotic component
- No malignant features
- No significant associated blood flow (especially no vascular pedicle)
CLUSTERED MICROCYSTS

MICROPAPILLARY DCIS

MICROCYSTS VS DCIS

PITFALL
MICROCYSTS VS DCIS

MANAGEMENT OF CLUSTERED MICROCYSTS

- Multiple vs solitary clusters
- Associated suspicious findings
- Correlation with other modalities
- Context
- Micropapillary DCIS much less common than clustered microcysts

DERMAL ORIGIN

cysts that arise from skin
sebaceous cyst appearances = BI-RADS 2

- Completely within skin
- Partially within skin
- Deep to skin

DERMAL ORIGIN

cysts of skin origin
lesion completely within skin = BI-RADS 2

- Sebaceous cysts
- Look for "claw sign" of skin wrapping around lesion
DERMAL ORIGIN

INFLAMMED SEBACEOUS CYST

MANAGEMENT OF DERMAL LESIONS
BASED ON CLINICAL SETTING

WHAT TO WORRY ABOUT

- Irregular or asymmetrically thickened walls
- Thick or enhancing septations
- Solitary or enlarging complicated cyst
- Any complex cystic mass
- Clusters of microcysts with significant solid components, flow or suspicious features

WHAT NOT TO WORRY ABOUT

- Multiple benign appearing complicated cysts and clusters of microcysts
  - Make sure they have no malignant features
  - Don’t try to follow (analogous to multiple mammographic nodules or calcifications)
  - If high risk setting, consider MRM
- Dermal lesions in uncomplicated settings

SOLID MASSES

Sonographic Features:
- Benign
- Indeterminate
- Suspicious
**BENIGN FEATURES**
- Markedly and uniformly hyperechoic to fat
  - Don’t cheat
- Ellipsoid shape / parallel axis
- Gently lobulated
- Thin continuous echogenic pseudocapsule
  - Multiple planes; angle
- Dermal in uncomplicated setting
- Morphologically benign lymph node

**FIBROADENOMA**

**INTRAMAMMARY NODE**

**INDETERMINATE FEATURES**
- Size
- Echogenicity other than markedly hyper- or hypoechoic
- Echotexture
- Normal or enhanced sound transmission
- Pattern of blood flow
MALIGNANT FEATURES

- Sonographic spiculation
- Taller than wide (non-parallel)
- Angular margins
- Markedly hypoechoic to fat
- Acoustic shadowing
- Punctate calcifications
- Duct Extension – towards the nipple
- Branch pattern – away from the nipple
- Microlobulation / Thick echogenic collar

INfiltrating Ductal CA

Ductal Carcinoma In Situ

Infiltrating and In Situ Ductal Carcinoma
INFILTRATING DUCTAL CA

INDISTINCT / MICROLOBULATED MARGINS

THICK ECHOGENIC COLLAR

INTRADUCTAL PAPILLOMA
WHAT TO WORRY ABOUT
- Any new or enlarging solid nodule that is not clearly an intramammary lymph node
- Any solid mass demonstrating any malignant feature
- Any change in a solid nodule originally felt to be benign and placed into follow-up
- Intraductal mass

WHAT NOT TO WORRY ABOUT
- Solid lesions with no malignant features and one of the following:
  - Intense and uniform hyperechogenicity
  - Parallel ellipsoid shape and thin continuous echogenic capsule
  - Gently lobulated and thin continuous echogenic capsule
  - This does not apply to new or enlarging masses
  - <2% risk of malignancy (Stavros); BI-RADS 3, imaging surveillance
- Single enlarging, but morphologically benign intramammary node
- Multiple similar solid nodules with no malignant features
  - Follow?
  - Biopsy something dominant and follow others?
  - Consider MRM?

REPORTING
- Integration with other modalities
- Answer the question
- Is follow-up appropriate or practical
- BI-RADS

SUMMARY
- Targeted exam
- Correlation with mammographic or clinical findings
- Optimize technical parameters
- Meticulous scanning
- Thorough documentation
- Integrated reporting, including BI-RADS
- Concise, practical recommendations