What’s New in Breast Imaging

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Objectives

• Be familiar with new breast imaging technologies including tomosynthesis, screening US, fast MRI, and contrast-enhanced spectral mammography (CESM).
• Describe the potential added benefit and potential negative aspects of screening women with these new modalities
• Understand how screening may be stratified based on risk and density

Disclosure

• Hologic, Inc. Shareholder and research agreement.
• Volpara Solutions, Ltd. Shareholder and research agreement.

Breast Cancer mortality has declined by >30% since 1990
Mammography

Limitations
- Many false positives; recall rates 2-15%
- Mortality reduced by 15-40% (film-screen)
- Sensitivity reduced in women with dense breasts

Potential Improvements
- Improve visualization of breast structures
- Functional imaging of blood flow or cellular activity

States with Density Legislation

New & Evolving Technologies
- Tomosynthesis (3D mammography)
- Screening US
- Fast MRI
- Contrast-enhanced spectral mammography

http://areyoudenseadvocacy.org/
New & Evolving Technologies

- Tomosynthesis (3D mammography)
- Screening US
- Fast MRI
- Contrast-enhanced spectral mammography

Digital Breast Tomosynthesis

- X-ray tube swings during tomo
- Stationary breast platform

Breast Tomosynthesis Acquisition

- X-ray tube moves through a proscribed arc of excursion
- 15 low-dose projection images are acquired during a 5-second sweep

Reduce Recalls

- Recall reduction of 16-40%

Cancers are More Apparent on Tomo

- Norwegian Breast Screening Program
- 12,631 exams, Nov 2010-Dec 2011
- Cancer detection
  - 6.1/1000 mammography alone
  - 8.0/1000 mammo + tomo
  - 30% increase in cancer detection
  - 40% increase in detection of invasive cancers

Skaane P. Radiology 2013
Primary Advantages of Tomo

• Reduce summation artifact resulting in improved specificity
• Improve visualization of cancers, resulting in improved sensitivity and cancer detection rate

Challenges with Tomo

• Higher radiation
• Increased interpretation time
• Reimbursement
• Not likely great for extremely dense tissue

Reducing Radiation with Tomo

• 2D + 3D is double radiation dose
• Dose reduced to similar level using synthesized 2D view
• No difference in cancer detection or recall rates
• ADD C VIEW IMAGE

New & Evolving Technologies

• Tomosynthesis (3D mammography)
• Screening US
• Fast MRI
• Contrast-enhanced spectral mammography
Screening US

- Bilateral whole breast US
- Radiologist or technologist performed
- Automated US commercially available

Screening US in “High” Risk Women

ACRIN 6666/Avon trial
- 2662 moderate and high-risk women had annual mammography screening US, over 3 years
- 111 cancers (110 women)
- Additional cancers by US
  - 5.3 CA/1000 Year 1
  - 3.7 CA/1000 Y 2 & 3
- 8.9% PPV for US lesions
- Additional 14.7 CA/1000 by MR

Berg WA. JAMA 2008
Berg WA. JAMA 2012

Screening US in Practice

- Studies from practices in CT
- Additional 3 cancers/1000
- 5-7% will have a biopsy
- PPV for biopsy 6.5-6.7%
- 9-20% BI-RADS 3

Weigert J. Breast J 2012
Hooley RJ, Radiology 2012

Connecticut was first with Breast Density Legislation
New & Evolving Technologies

- Tomosynthesis (3D mammography)
- Screening US
- Fast MRI
- Contrast-enhanced spectral mammography

Fast MRI

- Contrast Enhanced
  - One Pre T1, w fat sat
  - Two post contrast, w fat sat
- Non-contrast
  - T1, no fat sat
  - T2
  - Diffusion-weighted x 4

Current Breast MRI

New & Evolving Technologies

- Tomosynthesis (3D mammography)
- Screening US
- Fast MRI
- Contrast-enhanced spectral mammography
Contrast-Enhanced Spectral Mammography (CESM)

- IV iodinated contrast injection
- Wait 2 minutes
- Obtain routine mammographic views
  - Low energy exposure (26-30 kVp) - below k edge of iodine (33 kVp)
  - High energy exposure (45-49 kVp)

Fallenberg. Eur Radiol, 2014

Woman in her 50s, right nipple retraction

Sensitivity/Specificity of CESM

- 113 women with abnormal screening mammogram underwent CESM
- 32 cancers

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>ROC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D</td>
<td>96.9% (83.7-99.6)</td>
<td>42.0% (31.1-53.5)</td>
<td>39.7% (28.8-51.5)</td>
<td>97.1% (85.0-99.5)</td>
<td>0.779 (0.707-0.851)</td>
</tr>
<tr>
<td>CESM</td>
<td>100% (89.0-100.0)</td>
<td>87.7% (78.5-93.9)</td>
<td>76.2% (60.6-87.9)</td>
<td>100% (94.9-100)</td>
<td>0.976 (0.994-0.999)</td>
</tr>
</tbody>
</table>

Lobbes. Europ Radiol 2014
40s, palpable mass LUIQ

CESM may have Sensitivity and Specificity Similar to MRI
- 80 women with new breast cancer underwent MG, CESM, MRI
- Cancer visible in:
  - 66/80 MG
  - 80/80 CESM
  - 77/79 MRI

Fallenberg. Eur Radiol, 2014
**Potential Advantages**
- Functional imaging that may be similar in sensitivity and may be more specific as breast MRI
- Low cost
- Not limited by dense tissue

**Potential Disadvantages**
- Higher radiation - 80% higher than conventional 2D
- Reimbursement
- Allergic reactions to contrast

**New & Evolving Technologies**
- Tomosynthesis (3D mammography)
- Screening US
- Contrast-enhanced spectral mammography
- Fast MRI

**Current Breast Cancer Screening**
- Women
- Age 40 (50) and older
- Add Screening MRI if very high risk (>20% lifetime)
Conclusions

- Mammography reduces breast cancer mortality by 15-40%. This is important but leaves room for improvement.
- Tomosynthesis decreases recall rate and increases cancer detection by 30%. Results may not be equal across density categories.
- Screening US also increases cancer detection by 30%, but at the cost of low specificity. May be the current best option for ancillary screening of women with extremely dense tissue.
- MRI is highly sensitive for invasive breast cancer but is very expensive. Fast techniques may be possible for screening at lower cost.
- Contrast-enhanced spectral mammography (CESM) may have sensitivity similar to MRI at relatively low cost. May be best option for women with extremely dense breasts in the future.