AN UPDATE ON IMAGING

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Disclosures

• None
Conventional Mammography (2D FFDM)

• Routine 2-D mammography has “structured noise” due to overlapping tissues

• Cancers can be obscured
  – 20% breast cancers are not detected by conventional mammography
  – The sensitivity of mammography decreases with increasing breast density

• False positives caused by normal superimposed tissues
Digital Breast Tomosynthesis (DBT)

• DBT is a pseudo-3D breast imaging tool that is gaining widespread adoption
  – It has been shown to improve on the limitations of 2D mammography
    • Particularly improving the detection of lesions in dense breast tissue.

• FDA approved Feb 2011 and in practice at Yale since August 2011
**Breast Tomosynthesis Acquisition**

- X-ray tube moves through a prescribed arc of excursion
- 15 low-dose projection images are acquired during a 5-second sweep
- Total dose for a single acquisition < 150 mrad (1.5 mGy)

*Courtesy Hologic*
Screening and DBT

• With tomosynthesis:
  – Recalls decreased by 40%
  – Increased cancer detection rate at 40%
  – Increased detection of invasive cancers: 21%
<table>
<thead>
<tr>
<th>Author/year</th>
<th>2D</th>
<th>2D+DBT</th>
<th>% change</th>
<th>2D</th>
<th>2D+DBT</th>
<th>% change</th>
</tr>
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<tbody>
<tr>
<td>Ciatto, 2013</td>
<td>5.5</td>
<td>3.5</td>
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<td>5.3</td>
<td>8.1</td>
<td>53</td>
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<td>Skaane, 2013</td>
<td>6.1</td>
<td>5.3</td>
<td>-15</td>
<td>6.1</td>
<td>8.0</td>
<td>27</td>
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<td>Haas, 2013</td>
<td>12</td>
<td>8.4</td>
<td>-30</td>
<td>5.2</td>
<td>5.7</td>
<td>10</td>
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<td>Rose, 2013</td>
<td>8.7</td>
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<td>-37</td>
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<td>Friedewald, 2014</td>
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<td>9.1</td>
<td>-15</td>
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<td>McCarthy, 2014</td>
<td>10.4</td>
<td>8.8</td>
<td>-15</td>
<td>4.6</td>
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<td>Greenberg, 2014</td>
<td>16.2</td>
<td>13.6</td>
<td>-16</td>
<td>4.9</td>
<td>6.3</td>
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<tr>
<td>Durand, 2015</td>
<td>12.3</td>
<td>7.8</td>
<td>-37</td>
<td>5.7</td>
<td>5.9</td>
<td>4</td>
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<tr>
<td>Lourenco, 2015</td>
<td>9.3</td>
<td>6.4</td>
<td>-31</td>
<td>5.4</td>
<td>4.6</td>
<td>-17</td>
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<tr>
<td>Sharpe, 2016</td>
<td>7.5</td>
<td>6.1</td>
<td>-19</td>
<td>3.5</td>
<td>5.4</td>
<td>54</td>
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</table>
Synthesized Mammography (s2D+DBT)

• Decreases the radiation dose
• Preliminary studies demonstrate equivalence with 2D FFDM
# DBT and Radiation Dose

## TABLE 1: Comparison of Mean Glandular Dose of Digital Mammography (DM) Combined With Digital Breast Tomosynthesis (DBT) and DBT Alone

<table>
<thead>
<tr>
<th>Study</th>
<th>DM Combined With DBT (mGy)</th>
<th>DBT Alone (mGy)</th>
<th>% Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zuckerman et al. [7]</td>
<td>1.89 + 2.21</td>
<td>2.44</td>
<td>39</td>
</tr>
<tr>
<td>Skaane et al. [9]</td>
<td>1.58 + 1.95</td>
<td>1.95</td>
<td>45</td>
</tr>
<tr>
<td>Michell et al. [10]</td>
<td>1.37–1.57 + 1.66–1.90</td>
<td>1.66–1.90</td>
<td>45</td>
</tr>
</tbody>
</table>
- Aujero et al. (2017) Radiology

<table>
<thead>
<tr>
<th></th>
<th>2D FFDM</th>
<th>2D+DBT</th>
<th>s2D+DBT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall Rates</td>
<td>8.7%</td>
<td>5.8%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Cancer Detection Rate</td>
<td>5.3/1000</td>
<td>6.4/1000</td>
<td>6.1/1000</td>
</tr>
</tbody>
</table>

![Image of bar chart showing cancer detection rates from 2011 to 2016]
Tomosynthesis Reconstruction Slices
Diagnostic Work-Up

2D Mammography
- Spot compression
- Magnification
- True lateral
- Exaggerated CC
- Rolled CC
- Step Oblique
- Tangential

Tomosynthesis
- Magnification (for Ca++)
- Spot compression (fewer)
Proportion of Diagnostic and Screening Studies

- Total number of exams performed increased over time
- % US exams stayed relatively stable
- % diagnostic exams decreased
- % screening exams increased

<table>
<thead>
<tr>
<th></th>
<th>Screenings</th>
<th>Diagnostics</th>
<th>US</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D: 9/1/10-8/30/11</td>
<td>4914 (34%)</td>
<td>5086 (35%)</td>
<td>4392 (31%)</td>
<td>14413</td>
</tr>
<tr>
<td>3D2: 10/1/12-9/30/13</td>
<td>5726 (34%)</td>
<td>5387 (32%)</td>
<td>5711 (34%)</td>
<td>16906</td>
</tr>
<tr>
<td>3D3: 10/1/13-9/30/14</td>
<td>5764 (34%)</td>
<td>5043 (30%)</td>
<td>6001 (37%)</td>
<td>16813</td>
</tr>
<tr>
<td>3D4: 10/1/14-9/30/15</td>
<td>6710 (41%)</td>
<td>3805 (23%)</td>
<td>5900 (36%)</td>
<td>16415</td>
</tr>
<tr>
<td>3D5: 10/1/15-9/30/16</td>
<td>8724 (45%)</td>
<td>4200 (21%)</td>
<td>6622 (34%)</td>
<td>19546</td>
</tr>
</tbody>
</table>

Butler RB, Raghu M et al, RSNA 2016
Immediate Screening Results, i.e. Online Reads

- 2010-2011: 5%
- 2011-2012: 8%
- 2012-2013: 12%
- 2013-2014: 21%
- 2014-2015: 39%
- 2015-2016: 52%
Recalled from a 2D mammogram

USCNB: IDC; ER+, PR+, HER-2+
Stage: IB
Ultrasound and Breast Density
55 year old woman presents for routine screening
Spot compression views with tomosynthesis and targeted ultrasound was performed.

US guided CNBx: Invasive Lobular Carcinoma
Handheld WBUS

- Supplemental cancer detection rates: 3.0-4.3/1000
- ACRIN 6666: False positive rate of WBUS was 8.1% (4.4% for mammography)
  - Short term follow up was 8.6% versus 2.2% for mammography
- Utility of WBUS with DBT:
  - May be reduced
  - If screening is done with DBT and MRI
    - No incremental benefit with US
Breast MRI

• Recommend annual MRI (age 25-30)
  – Genetics based increased risk
  – History of chest radiation
  – Calculated lifetime risk of 20% or more
• Recommend annual MRI:
  – Women with history of breast cancer and dense breasts
  – Diagnosed before 50
• May consider for history of atypia
Cancer detection rate: 17/1000
Median size of invasive: 1 cm; 88% node neg
Sensitivity: 81%; Specificity: 83%
## TABLE 3: Comparison of Screening MRI Performance Metrics After Negative 2D Full-Field Digital Mammography (FFDM) Versus Digital Breast Tomosynthesis (DBT)

<table>
<thead>
<tr>
<th>Performance Metric</th>
<th>No. / Total No. (%)</th>
<th>Odds Ratio (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FFDM Group</td>
<td>DBT Group</td>
<td></td>
</tr>
<tr>
<td>Supplemental CDR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw data</td>
<td>26/2291 (1.1)</td>
<td>34/2127 (1.6)</td>
<td>1.4 (0.4–1.2)</td>
</tr>
<tr>
<td>Per 1000 examinations</td>
<td>11/1000 (1.1)</td>
<td>16/1000 (1.6)</td>
<td>1.4 (0.4–1.2)</td>
</tr>
<tr>
<td>Abnormal interpretation ratea</td>
<td>170/2291 (7.4)</td>
<td>155/2127 (7.3)</td>
<td>1.0 (0.8–1.3)</td>
</tr>
<tr>
<td>PPV1</td>
<td>26/170 (15)</td>
<td>34/155 (22)</td>
<td>1.5 (0.4–1.2)</td>
</tr>
<tr>
<td>PPV2</td>
<td>18/77 (23)</td>
<td>32/98 (33)</td>
<td>1.6 (0.3–1.3)</td>
</tr>
<tr>
<td>PPV3</td>
<td>18/64 (28)</td>
<td>32/92 (35)</td>
<td>1.5 (0.3–1.5)</td>
</tr>
</tbody>
</table>

Note—CDR = cancer detection rate, PPV = positive predictive value.

*a Numerators reflect MRI examinations given an initial BI-RADS 0, 3, 4, or 5, which differ slightly from final BI-RADS counts shown in Table 2. Two examinations from the FFDM group and three examinations from the DBT group given an initial BI-RADS 0 were assigned a final BI-RADS 2 assessment.
Rapid Breast MRI

• Ongoing studies
• Abbreviated MRI protocol
• Harvey et al (2017):
  – Included 1052 MRIs
  – CDR was 13.3/1000
  – PPV3 of 30.4%
  – Sensitivity and specificity were not significantly different for abbreviated versus full protocols
Conclusions

• Technology evolving

• Applications of the current technology is also changing

• Role of AI may a player in the future
Thank you!
Questions?

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