Breast Imaging Modalities in Clinical Practice

A Breast Radiologist’s Perspective

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Assistant Member, Division of Breast Imaging
Moffitt Cancer Center

Disclosures

• Nothing to disclose

Outline

• Screening vs Diagnostic Indications
• Discuss Risk Assessment
• Breast Cancer Epidemiology
• Screening Mammography
• Focused Clinical Update on Breast Imaging Modalities
  • Digital Breast Tomosynthesis (DBT)
  • Synthetic Mammography (SM)
  • Contrast Enhanced Digital Mammography (CEDM)
  • Stereotactic vs. DBT guided core biopsies
• Future of Breast Imaging
Definitions

Screening vs. diagnostic exam?

Screening Exam
- Asymptomatic

Diagnostic Exam
- Symptomatic
- Abnormal screening exam
- Follow up of a BI-RADS 3 finding

How does a patient’s risk of developing breast cancer influence the recommendation for screening?
High risk women: annual mammography \textbf{AND} annual breast MRI recommended

High Risk is defined as those with a:

\begin{itemize}
\itemLifetime risk (LTR) of developing breast cancer $\geq$ 20-25% 
\itemDisease-causing genetic mutation(s) (e.g. BRCA, p53, PTEN, STK11)
\itemFirst-degree relative with a known disease-causing mutation (but who are themselves untested)
\itemHistory of prior chest radiation therapy before age 30
\itemHereditary or genetic syndrome associated with an increased risk for developing breast cancer (Li-Fraumeni, Cowden, or Bannayan-Riley-Ruvalcaba Syndromes)
\itemPersonal history (pHx) of breast cancer and dense breast tissue and/or those with a pHx of breast cancer diagnosed before the age of 50
\end{itemize}

How is breast cancer risk assessed?
Risk Assessment Models

- Statistical models that combine known major risk factors
- Predict:
  - Risk of developing invasive breast cancer
  - Risk of pathogenic mutation
  - Both
- Stratify pts into risk categories to personalize screening and surveillance plans

How are the models used?

To identify women who:
- Meet criteria for high-risk screening breast MRI
- May carry a pathogenic mutation and benefit from genetic risk assessment
- May benefit from risk-reducing medications

Breast Cancer

- Approximately 12% of women (1/8) will be diagnosed with breast cancer at some point during their lifetime
- Second leading cause of cancer death among women
Localized Regional Distant

5-year Relative Survival Rate (Percent)

Based on the SEER (Surveillance, Epidemiology, and End Results) database, maintained by the National Cancer Institute (NCI), available on the ACS website. The data displayed is based on women diagnosed with breast cancer between 2008 and 2014.

Screening Mammography

- Multiple randomized control trials (RCTs) since the 1960s
- Mortality reduction 25-30%
- Smaller and more node-negative tumors

<table>
<thead>
<tr>
<th>Trial (year)</th>
<th>Age at Entry</th>
<th># of views</th>
<th>Frequency of Mammography (mo)</th>
<th>Rounds (y)</th>
<th>F/U (y)</th>
<th>RR (95% CI)</th>
<th>Mortality Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIP trial (1963-1969)</td>
<td>40-64</td>
<td>2</td>
<td>12</td>
<td>4</td>
<td>18</td>
<td>0.78 (0.64-0.97)</td>
<td>22</td>
</tr>
<tr>
<td>Malmö, Sweden (1976-1980)</td>
<td>46-69</td>
<td>1-2</td>
<td>18-24</td>
<td>5</td>
<td>20</td>
<td>0.79 (0.65-0.95)</td>
<td>22</td>
</tr>
<tr>
<td>Two-County Swedish (1979-1988)</td>
<td>40-74</td>
<td>1</td>
<td>23-33</td>
<td>4</td>
<td>30</td>
<td>0.88 (0.54-0.88)</td>
<td>32</td>
</tr>
<tr>
<td>Edinburgh, Scotland (1975-1980)</td>
<td>45-64</td>
<td>1-2</td>
<td>24</td>
<td>4</td>
<td>14</td>
<td>0.78 (0.62-0.97)</td>
<td>22</td>
</tr>
<tr>
<td>Stockholm, Sweden (1981-1988)</td>
<td>40-64</td>
<td>1</td>
<td>28</td>
<td>2</td>
<td>16</td>
<td>0.80 (0.63-0.98)</td>
<td>20</td>
</tr>
<tr>
<td>Gothenburg, Sweden (1982-1988)</td>
<td>40-69</td>
<td>2</td>
<td>18</td>
<td>4</td>
<td>14</td>
<td>0.75 (0.58-0.98)</td>
<td>21</td>
</tr>
<tr>
<td>UK Age trial (1991-2000)</td>
<td>39-41</td>
<td>1-2</td>
<td>12</td>
<td>8</td>
<td>10</td>
<td>0.83 (0.60-1.10)</td>
<td>17</td>
</tr>
</tbody>
</table>

Challenges with Mammography

• Heterogeneity of a normal mammogram
• FFDM is limited
  • Overlapping tissue can simulate disease
  • Overlapping tissue can obscure cancers

Digital Breast Tomosynthesis (DBT)

• X-ray tube moves in an arc
• Multiple low dose projection images obtained
• Mathematical reconstruction of imaging planes from a set of projection images obtained through a limited angle

Figure: Peppard III et al. Radiographics 2015
Table 1: Commonly FDA-approved DBT Systems.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Hologic Selectra</th>
<th>GE BaseLine</th>
<th>Siemens Mammaprimary</th>
<th>Fuji Infinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan type</td>
<td>3D</td>
<td>3D</td>
<td>2D</td>
<td>2D</td>
</tr>
<tr>
<td>Field size</td>
<td>6G (700 µm)</td>
<td>6G (330 µm)</td>
<td>6G (200 µm)</td>
<td>6G (200 µm)</td>
</tr>
<tr>
<td>Tube voltage</td>
<td>Continuous step and dwell</td>
<td>Continuous step and dwell</td>
<td>Continuous step and dwell</td>
<td>Continuous step and dwell</td>
</tr>
<tr>
<td>Detector</td>
<td>Amorphous Bi</td>
<td>Amorphous Bi</td>
<td>Amorphous Bi</td>
<td>Amorphous Bi</td>
</tr>
<tr>
<td>Pixel size (µm)</td>
<td>163 x 131</td>
<td>152 x 124</td>
<td>16 x 13</td>
<td>16 x 13</td>
</tr>
<tr>
<td>Grid (mm)</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Reconstruction algorithm</td>
<td>3D</td>
<td>3D</td>
<td>3D</td>
<td>3D</td>
</tr>
</tbody>
</table>

DBT Screening Studies

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Vendor</th>
<th>Volumes (n)</th>
<th>Study Type</th>
<th>DM vs. DBT</th>
<th>Recall Rate</th>
<th>Cancer Detection Rate (per 1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skaane (2013)</td>
<td>Hologic</td>
<td>12,631 multi reads</td>
<td>Prospective</td>
<td>DM: 6.1 to 5.3% 15% reduction</td>
<td>6.1 to 8.0 27% increase (p&lt;0.001)</td>
<td></td>
</tr>
<tr>
<td>Ciatto (2013)</td>
<td>Hologic</td>
<td>7292 DM then DBT</td>
<td>Prospective</td>
<td>DM: 4.5 to 3.5 % 17.2% &quot;conditional&quot; reduction</td>
<td>5.3 to 8.1/1000 (cancers overall not by pt) 52.8% increase</td>
<td></td>
</tr>
<tr>
<td>Friedewald (2014)</td>
<td>Hologic</td>
<td>454,850 DBT: 173,663 DM: 281,187</td>
<td>Retrospective</td>
<td>DM vs. DBT: 10.7 to 9.1% 15% reduction (p&lt;0.0001)</td>
<td>4.2 to 5.4 (p&lt;0.001)</td>
<td></td>
</tr>
<tr>
<td>Greenberg (2014)</td>
<td>Hologic</td>
<td>59,617 DBT: 20,943 DM: 38,674</td>
<td>Retrospective</td>
<td>DM vs. DBT: 16.2 to 13.6% 16% reduction (p&lt;0.001)</td>
<td>4.9 to 6.6 (p&lt;0.005)</td>
<td></td>
</tr>
<tr>
<td>Lourenco (2015)</td>
<td>Hologic</td>
<td>25,299 DBT: 12,921 DM: 12,577</td>
<td>Retrospective</td>
<td>DM vs. DBT: 9.3 to 6.4% 31% reduction (p&lt;0.0001)</td>
<td>5.4 to 4.6 (p&lt;0.04)</td>
<td></td>
</tr>
</tbody>
</table>
Additional Uses of DBT in Screening & Diagnostic Workups

- Characterization of benign breast findings
- Margin characterization
  - DBT obviates need for additional views
  - Enhanced margin characterization
- Localization

DBT vs. FFDM Imaging after Recall

- Fewer mammograms
- More US only
- Fewer combination of mammogram views and US

Lourenco et al. Radiology 2015

DBT vs. Supplemental diagnostic DM views

- 217 lesions / 182 patients
- Mix of benign and malignant lesions assessed with 2D FFDM + DBT
- BI-RADS assessments and a probability-of-malignancy (POM) scores
- FP rate ↓ from 85% to 74% with DBT for cases rated BI-RADS 3 or higher WITHOUT significant change in sensitivity
- With DBT, more cancers were classified as BI-RADS 5 (39% vs. 33%) WITHOUT a decrease in specificity

Zuley et al. Radiology 2013
DBT vs. Supplemental diagnostic DM views

- DBT significantly improved diagnostic accuracy for noncalcified lesions compared with supplemental mammographic views.

Zuley et al. Radiology 2013

Implementation of DBT

- Triaging patients in hybrid FFDM/DBT practices
- DBT 37.3% of mamm systems certified by FDA
- DBT available at 61.9% of certified breast imaging facilities in US
- Reading and acquisition times
- Dose considerations

McDonald ES et al. AJR 2015

<table>
<thead>
<tr>
<th>Entire Screening Cohort</th>
<th>DM</th>
<th>DBT</th>
<th>Change from DM to DBT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDR (per/1000)</td>
<td>4.6</td>
<td>5.5</td>
<td>+ 19.6 %</td>
</tr>
<tr>
<td>Recall Rate (%)</td>
<td>10.4</td>
<td>8.8</td>
<td>- 15.4 %</td>
</tr>
<tr>
<td>PPV1 (cancer/recalls)</td>
<td>4.4</td>
<td>6.2</td>
<td>+ 40.3 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Baseline Subgroup</th>
<th>DM</th>
<th>DBT</th>
<th>Change from DM to DBT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDR (per/1000)</td>
<td>4.2</td>
<td>5.9</td>
<td>+ 40.5 %</td>
</tr>
<tr>
<td>Recall Rate (%)</td>
<td>20.5</td>
<td>16</td>
<td>- 22 %</td>
</tr>
<tr>
<td>PPV1 (cancer/recalls)</td>
<td>2</td>
<td>1.7</td>
<td>+ 41 %</td>
</tr>
</tbody>
</table>

If limited resources, women < 50 years with no priors available or undergoing baseline screening may benefit more from DBT than from DM alone.

McDonald ES et al. AJR 2015
Effect on Image Interpretation Time

- 10 radiologists read images from screening FFDM/DBT vs FFDM exams
- 1 hr uninterrupted sessions; at least 5 sessions / rad / modality
- Avg # of studies read: 23.8 ± 0.55 for FFDM/DBT vs 34.0 ± 0.55 for FFDM alone
- Avg interp time: 2.8 min ± 0.9 for FFDM/DBT vs. 1.9 min ± 0.6 FFDM
- 47% avg increase interp time per rad - 10 fewer studies/hr for FFDM/DBT
- 9/10 had an increased interp time for DBT despite years of experience

Dang PA et al. Radiology 2014

Acquisition and Reading Times

**Acquisition Time**
- 7 technologists, 20 cases
- Avg FFDM/DBT Combo time: 4 min 3 sec
- Avg FFDM time: 3 min 13 sec (p<0.01)

**Reading Time**
- 3 radiologists, 100 cases
- Avg FFDM/DBT Combo time: 77 sec
- Avg FFDM time: 33 sec (p<0.01)

Bernardi et al. Br J Radiol 2012

Summary of Workflow After Implementing DBT

- ↑ acquisition time
- ↑ interp time
- ↓ recalls
- ↓ diagnostic mammo images
- No staffing change
Although the radiation dose is below the MQSA limit of 3 mGy per view, there is over a two-fold (approx 2.25) increase when comparing FFDM with FFDM/DBT.

How can we reduce the dose?

Synthetic Mammography (SM)
- Synthetic images reconstructed from DBT dataset
- No additional radiation dose
- FDA approval in 2013
SM/DBT vs FFDM/DBT: Dose

- 15,571 women screened w FFDM/DBT; 5,366 women screened w SM/DBT
- Average glandular dose (AGD)
  - 4.88 mGy for SM/DBT
  - 7.97 mGy for FFDM/DBT (p < .001)
- AGD was reduced by 39% with SM/DBT compared to FFDM/DBT

Zuckerman et al. Radiology 2016

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Study Conclusions</th>
</tr>
</thead>
</table>
| Zuley et al (2014) | - SM alone has a comparable AOC to DM alone  
                      - SM/DBT has a comparable AOC to FFDM/DBT                                     |
| Skaane et al (2014)| - SM/DBT and FFDM/DBT have comparable CDRs  
                      - SM/DBT and FFDM/DBT have comparable FP rates                                   |
                      No statistically significant difference in specificity of SM/DBT and FFDM/DBT |
| Zuckerman et al (2016)| No statistically significant difference in CDR between SM/DBT and FFDM/DBT  
                          SM/DBT reduces recall rates and dose compared to FFDM/DBT (p<0.001)           |
| Aujero et al (2017) | No statistically significant difference in CDR between SM/DBT and FFDM/DBT  
                      SM/DBT reduces recall rates compared to FFDM/DBT (p<0.0001)                    |

Modified from: Ratanprasartporn L et al. RadioGraphics 2017

Synthetic Mammography (SM)

**Strengths**
- ↓ radiation dose
- ↓ acquisition time
- ↑ conspicuity of calcifications
- ↑ definition of spiculated margins/distortions

**Weaknesses/Artifacts**
- Pseudocalcifications
- Foreign-body or metal artifacts
- Difficulty in assessing motion
- Subcutaneous tissue blurring & loss of skin resolution
- ↓ axillary contrast resolution
SM Implementation into Clinical Practice

- 312/2600 SBI respondents
- 96% (299/312) reported DBT capability and 80% (249/312) reported SM capability
- 45% use SM without DM for all DBT screens
- Although SM is utilized by a majority of practices, it has not widely replaced DM

DBT Summary

- ↑ CDR
- ↓ RR
- Diagnostic accuracy of SM/DBT comparable to FFDM/DBT

Incremental CDR

<table>
<thead>
<tr>
<th>Modality</th>
<th>CDR (per 1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammography</td>
<td>3-3.5</td>
</tr>
<tr>
<td>+DBT</td>
<td>+0.2</td>
</tr>
<tr>
<td>+US*</td>
<td>+4</td>
</tr>
<tr>
<td>+MRI**</td>
<td>+15</td>
</tr>
</tbody>
</table>

*Berg, W et al. JAMA 2008
**Berg, W et al. JAMA 2012
Supplemental Breast MRI Screening in Average Risk Women

- 2120 women - 3861 screening MRI studies
- Overall supplemental CDR of 15.5 per 1000 cases (22.6/1000 at prevalence screening)
- Of the 61 malignant lesions, 26 (43%) exhibited high nuclear grades (95% CI: 30.0, 55.9) and 20 (33%) (95% CI: 21, 46) ER/PR neg cancers.
- Cancers diagnosed were small (median, 8 mm), node negative in 93.4% of cases, and dedifferentiated (high-grade cancer) in 41.7% of cases at prevalence screening and 46.0% of cases at incidence screening.

Kuhl et al. Radiology 2017

Some Limitations of Breast MRI

- Cost
- Metallic implants / devices
- Claustrophobia
- Gadolinium contrast allergy

Breast Imaging

- Anatomic
  - Mammography
  - DBT
  - Ultrasound
- Physiologic
  - MRI
  - CEDM
  - MBI
Contrast Enhanced Digital Mammography (CEDM)

- FDA approved October 2011
- GE, Siemens, Hologic have FDA approved units
- DM units adapted to perform low and high energy exposures
- Contrast screening process
  - Nurse or tech interviews pt and starts IV
  - Contrast allergy history
  - Renal function evaluation per same criteria for CT studies

- Iodinated contrast administered via IV
  - Approximately 3 ml/s – power injector
  - 300 – 370 mg/mL iodine concentration
  - 1.5 ml/kg body weight → typically 90–150 mL total
- After a delay of at least 90 seconds, pt positioned for mammo views
  - Positioning starts at approx. 2 min 15 sec – 1st exposure 2 min 45 sec

- Two images of each breast obtained, dual-energy image pairs in each projection
- Weighted subtraction performed – nonenhancing tissue is eliminated and enhancement/iodine is shown
- Low keV images are identical to standard unenhanced mammogram, serve as standard digital mammogram for interpretation
- Typically one time point (no kinetic information)
- Radiation dose 1.2-1.8x of DM

*Phillips J et al. AJR 2018
Table 2: Overview of the diagnostic performance of mammography versus contrast-enhanced spectral mammography (CESM)

<table>
<thead>
<tr>
<th>Metric</th>
<th>Mammography</th>
<th>CESM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity (%)</td>
<td>96.9 (83.7–99.5)</td>
<td>100.0 (89.8–100.0)</td>
</tr>
<tr>
<td>Specificity (%)</td>
<td>42.0 (31.1–53.5)</td>
<td>87.7 (78.5–93.9)</td>
</tr>
<tr>
<td>Positive predictive value (%)</td>
<td>39.7 (28.8–51.5)</td>
<td>76.2 (66.6–87.9)</td>
</tr>
<tr>
<td>Negative predictive value (%)</td>
<td>97.1 (85.0–99.3)</td>
<td>100.0 (94.9–100.0)</td>
</tr>
<tr>
<td>Area under the ROC curve</td>
<td>0.779 (0.707–0.851)</td>
<td>0.976 (0.954–0.999)</td>
</tr>
</tbody>
</table>

95% confidence intervals are in parentheses


Diagnostic performance of dual-energy contrast-enhanced subtracted mammography in dense breasts compared to mammography alone: interobserver blind-reading analysis

Table 3: Average sensitivity, specificity, PPV, NPV, and accuracy of Mx alone and Mx + CESM

<table>
<thead>
<tr>
<th>Metric</th>
<th>Mx alone</th>
<th>Mx + CESM</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>71.8</td>
<td>82.3</td>
<td>21.2</td>
</tr>
<tr>
<td>Specificity</td>
<td>51.8</td>
<td>67.8</td>
<td>16.1</td>
</tr>
<tr>
<td>PPV</td>
<td>81.0</td>
<td>88.2</td>
<td>8.2</td>
</tr>
<tr>
<td>NPV</td>
<td>61.8</td>
<td>76.5</td>
<td>37.4</td>
</tr>
<tr>
<td>Accuracy</td>
<td>65.9</td>
<td>85.8</td>
<td>19.9</td>
</tr>
</tbody>
</table>

PPV: positive predictive value, NPV: negative predictive value, Mx: conventional mammography, Mx + CESM: contrast-enhanced subtracted mammography

Cheung YC et al. Eur Radiol 2014
**CEDM & MRI**

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>No. of Subjects</th>
<th>CEDM Result (%)</th>
<th>MRI Result (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jochelson et al (2017)</td>
<td>307</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>Li et al (2017)</td>
<td>48</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Jochelson et al (2013)</td>
<td>52</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>Zhu et al (2018)*</td>
<td>2859</td>
<td>89</td>
<td>---</td>
</tr>
</tbody>
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**Sensitivity**

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>No. of Subjects</th>
<th>CEDM Result (%)</th>
<th>MRI Result (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luczynska et al (2010)</td>
<td>103/118</td>
<td>79</td>
<td>73</td>
</tr>
<tr>
<td>Cao et al (2010)</td>
<td>105</td>
<td>88</td>
<td>90</td>
</tr>
<tr>
<td>Zhu et al (2018)*</td>
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</table>

**Accuracy (AUC)**

<table>
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<th>Study (Year)</th>
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<td>2859</td>
<td>89</td>
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</table>

*meta-analysis of 18 studies

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**Prospective screening study**

- 307 heavily pre-screened patients
- PPV3 for CEDM 15.4% [95% CI: 1.9–45.43, 2/13] vs. MRI 14.3% [95% CI: 3.0–36.3%, 3/21], p = 0.86.
- Specificity: CEDM 94.7% [91.6–97] and MRI 94.1% [90.8–96.4]
- False positive rates: CEDM 5.3% [3.6–8.4] and MRI 5.9% [3.6–9.2].

**Utility of CEDM for Breast Cancer Screening**

- 1197 CEDM studies performed in high-risk population
- CDR of 18/1000
- PPV of biopsy - 31%

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How does CEDM compare with DBT?

- 185 patients with BI-RADS 4 or 5 lesions evaluated before bx with DM, DBT, CEDM, CE-DBT and DCE-MRI.
- 81 cancers/144 benign lesions
- Significant differences in AUC were found between the group of contrast enhanced modalities (CEDM, CE-DBT, DCE-MRI) and the unenhanced modalities (all p < 0.05).
- No significant differences were found in AUC between DCE-MRI, CET and CEDM (all p > 0.05).

Chou et al. Euro Radiol 2015

Uses of CEDM

**Non-Cancer Patients**
- Evaluate abnormal screening examinations
- Problem solving / evaluation inconclusive imaging findings
- Assess pts with clinical symptoms
- Supplemental screening
  - High-risk women
  - Dense breast tissue

**Suspected/Known Cancer**
- Evaluate extent of disease
- Monitor response of neoadjuvant therapy

*EUSOBI: CEDM can be considered as an alternative to MRI in the case of MRI contraindications

Relative Advantages

<table>
<thead>
<tr>
<th>CEDM</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower cost</td>
<td>No ionizing radiation</td>
</tr>
<tr>
<td>Shorter exam time</td>
<td>Chest wall and axillary imaging/visualization</td>
</tr>
<tr>
<td>Detection of calcifications</td>
<td>Less risk of contrast reaction</td>
</tr>
<tr>
<td>No claustrophobia or loud noises</td>
<td>Full characterization of enhancement (kinetics)</td>
</tr>
<tr>
<td>No MRI-specific contraindications (pacemakers/implanted metal)</td>
<td>MRI-guided biopsy is available</td>
</tr>
<tr>
<td>No risk of NSF or gadolinium deposition</td>
<td></td>
</tr>
</tbody>
</table>

Workflow Issues for CEDM: Biopsy

• Biopsy mechanism being tested but **not** commercially available yet
• If seen on mammography or ultrasound → biopsy
• If not seen on mammography or US → MRI → MRI biopsy
• If not seen on MRI → 6 month follow up CEDM

Workflow Issues for CEDM: Contrast

• Nurse or tech to obtain history, screen, & place IV
• Contrast allergies/reactions
  • 1.3% of patients*
  • Screen carefully for contrast contraindications
  • Learn to manage contrast allergies/reactions
  • Crash cart in room

*Jochelson et al. Eur J Radiol 2017

CEDM Summary

• Superior to unenhanced mammography/DBT
• Comparable to MRI in sensitivity and diagnostic accuracy
• Well tolerated by patients
• CEDM biopsy mechanism being tested
• Additional large prospective studies needed to validate initial data
Stereotactic / DBT guided Biopsy

Indications for Stereotactic/DBT guided Biopsy

• Suspicious calcifications
• Suspicious asymmetry/mass/distortion with no sonographic correlate

Stereotactic/DBT guided Biopsy

• Typically 9 G vacuum assisted biopsy needle
• Standard size (20 mm trough); Petite (12 mm trough)
• 6-12 samples taken
• Clip placed
Prone Stereotactic VAB
• Small field of view/biopsy window

DBT guided VAB
• Full detector field for imaging

Prone Stereotactic VAB
• Triangulation required to produce Z axis/depth info

DBT guided VAB
• Provides immediate lesion depth information (slice # determines Z)
Prone Stereotactic VAB
- Mean biopsy time – 29 ± 10.1 min*
- 93% technical success (154/165)*
- Inability to visualize lesion in 5 cases

DBT guided VAB
- Mean biopsy time – 13 ± 3.7 min*
- 100% technical success (51/51)*
- Low contrast targets
- DBT only findings

*Schrading et al. Radiology 2015

What about calcifications?

<table>
<thead>
<tr>
<th>Authors (Reference)</th>
<th>Publication Year</th>
<th>Imaging Modality</th>
<th>Percentage of Cases with Conspicuity Better than or Equal to That at FFDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poplack et al (54)</td>
<td>2007</td>
<td>DBT</td>
<td>45</td>
</tr>
<tr>
<td>Kopans et al (56)</td>
<td>2011</td>
<td>DBT</td>
<td>92</td>
</tr>
<tr>
<td>Sivane et al (57)</td>
<td>2011</td>
<td>DBT</td>
<td>92</td>
</tr>
<tr>
<td>Demouots et al (55)</td>
<td>2013</td>
<td>DBT</td>
<td>92.2</td>
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<tr>
<td>Hwang et al (52)</td>
<td>2018</td>
<td>SM</td>
<td>83.3</td>
</tr>
<tr>
<td>Mariscotti et al (12)</td>
<td>2017</td>
<td>SM</td>
<td>94.2</td>
</tr>
</tbody>
</table>

Horvat et al RadiGraphics 2019

DBT guided VAB for Breast Calcifications

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ biopsy time</td>
<td>Rarely, fine calcifications not well visualized by DBT</td>
</tr>
<tr>
<td>↑ detection of associated masses/distortions</td>
<td></td>
</tr>
<tr>
<td>Allows for dx of skin calcs</td>
<td></td>
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<tr>
<td>Better avoidance of blood vessels</td>
<td></td>
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<tr>
<td>↓ tissue overlap</td>
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</tbody>
</table>
What does the future hold?

Tall Order For Breast Imaging

- Detect cancer
- Stage cancer
- Monitor disease / assess response to therapy
- Predict pathologic complete response (pCR)
- Predict recurrence free survival (RFS)
- Predict overall survival (OS)

all while

- ↓ FP
- ↓ FN
- ↓ cost
- ↓ dose
- ↓ time
- ↓ anxiety
- ↓ overtreatment
- ↓ overdiagnosis

Thank You
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