Advanced Imaging for Breast Cancer: Screening, Diagnosis, and Assessing Response to Therapy

Breast CT

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Breast CT Technology

Preliminary Clinical Assessments
Mathematical Observer Metrics
Lesion Insertion / t3D versus 2D
Anatomical noise / M↔T↔bCT
CE-bCT versus Mammo and Tomo
Summary

Disclosures (required by UC Davis):

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Medical Physics

Dedicated Breast CT:
Radiation Dose and Image Quality Evaluation

A comprehensive analysis of DgN CT coefficients for cone-beam breast computed tomography

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Breast CT Dose – Two View mammography

UC Davis Medical Center

Albion
Bodega
Cambria
Doheny

Albion 2004
Bodega 2007
Cambria 2012
Doheny 2013
Breast CT

Breast CT Technology

- Preliminary Clinical Assessments

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Spatial Resolution: Modeled & Measured MTF's

Albion & Bodega

Cambria (2 x 2) [388 μm pixels]

Cambria (1 x 1) [194 μm pixels]

Doheny

3X Spatial Resolution

Breast CT

first breast cancer imaged: January 2005

second volunteer imaged: January 2005
Dedicated Breast CT: Initial Clinical Experience

PRE CONTRAST

POST CONTRAST

bCT (no injected contrast)

bCT (with contrast)
Breast CT

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Summary

\[ \sum (f_i \times I_i) = d' \]

Pre-whitened matched filter
"computer observer"

Lesion absent
Lesion present

# observations
Effect of slice thickness on detectability in breast CT using a prewhitened matched filter and simulated mass lesions

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Summary

Background Noise

Anatomical Noise

mass lesions only / results do not reflect microcalcifications
Digital Subtraction Angiography
(Temporal Subtraction)
Reduces Anatomical Noise

Dual Energy Chest Radiography
(Energy Subtraction)
Reduces Anatomical Noise

27 patients were imaged using all 3 modalities

Anatomical complexity in breast parenchyma and its implications for optimal breast imaging strategies

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Association between power law coefficients of the anatomical noise power spectrum and lesion detectability in breast imaging modalities

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Dense Breasts

Adipose Breasts

bCT, Tomo, and Mammo Comparisons

N = 23 pts
1000 ROIs per breast CT mammography tomosynthesis

breast CT

mammo

Tissue Thickness (mm)

0 10 20 30 40 50

slice thickness (mm)

Tomo

Coronal Sagittal Axial CC MLO CC MLO

files in breast

beta

0.1 0.5

Volume Glandular Fraction (%)
measured data on the breast CT system

tomographic angle

<table>
<thead>
<tr>
<th>disk diameter (mm)</th>
<th>15°</th>
<th>90°</th>
<th>45°</th>
<th>60°</th>
<th>90°</th>
<th>120°</th>
<th>180°</th>
<th>360°</th>
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<tbody>
<tr>
<td>2.5 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Breast CT Images

Mammo

0 mm | 5 mm | 10 mm | 15 mm | 20 mm | 25 mm | 30 mm | 35 mm | 40 mm | 45 mm | 50 mm | 55 mm

Breast CT

Tomosynthesis Images

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Prospective Clinical Trial

105 patients /103 lesions (BIRADS 4 or 5)
- imaged on VCO mamm / tomo / CE-bCT
- all biopsied

<table>
<thead>
<tr>
<th></th>
<th>microcalcifications</th>
<th>masses</th>
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<tr>
<td>malignant</td>
<td>31</td>
<td>27</td>
</tr>
<tr>
<td>benign</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>total</td>
<td>58</td>
<td>45</td>
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</tbody>
</table>

2 Radiologists Rated Lesions using a 0 to 10 Conspicuity Score
0 = not seen  10 = excellent

one-way ANOVA with correction for multiple comparisons

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Breast CT (Summary)

Patients find bCT more comfortable
Radiation dose is the same as 2V mammography
Early trials and computer sims show better mass lesion detection performance than mammography
Computer simulations show bCT reduces anatomical noise / Mammo or Tomo / reasons understood
CE-bCT has better sensitivity and specificity than mammo or tomo

Embargoed Data until Published (so not in printed notes)
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