Why breast CT?

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Why do we need Breast CT?

- Who does not have a loved one who had breast cancer?
- Breast cancer #1 cancer in US women (excluding skin cancer)
- #2 cause of cancer death in US women
- 44,000 women die each year

We screen for breast cancer

- Small <1cm
- Early-no nodes (>98% 5 year survival)
Small cancers

- Less invasive surgery
- Less axillary lymph node surgery
- Less radiation
- Less or no chemotherapy

Gold standard

- Mammography
- Deaths down >30% past 20 years
- Unchanged for prior 50 years

Design an imaging device

- Object: to find small white cancers
- In a breast which is a 3D object
- Where fat is black
- Everything else is white
  - glandular tissue, connective tissue
  - cysts, fibroadenomas ... and cancer
Current imaging of the breast

- First transform it from 3D to 2D
- Then use compression- >25 pounds
- That's uncomfortable!
- Do it at least twice (2 views minimum)
- Find something - need spots, mags, laterals, all extra views, all with compression

To image the breast

- Then maybe do ultrasound
- And maybe needle biopsy
- Now, how's the patient doing?
Consider dedicated breast CT

- one acquisition
- "manipulate the image, not the patient"
- Can do high res 0.122 mm
  -(standard 0.273mm)
- Co-register all findings
- correlate a finding seen on one view
Mammo sensitivity

- 85% at best
- <50% in dense breasts
- >40% women in the US have dense breasts
- Increased risk of cancer in dense vs fatty (4-6x relative risk)

Problems with mammography

- Dense tissue
- Compression
- Uncomfortable
- Need something better
We need 3D imaging

- Breast is a 3D structure
- Compression causes tissue overlap
- Mammography has distortion—false positives and false negatives
- Women don’t like it!

We have tomosynthesis

- Tomo is a better mammogram
- But tomo is not truly 3D
- It is 2D reconstructed to “3D”
- It still needs compression and 2 views per breast
- Doubles radiation dose of mammogram

We have 3D ultrasound

Whole breast
Reconstructed to 3D
Need to correlate with mammogram
### ACRIN 6666 (2008)

- Sensitivity of mammography: 50%
- Ultrasound added to mammography: 77.5%
- But PPV for biopsy: <10%
  - (91.4% biopsies were benign)
- Cost: >$60,000 per cancer

### We have MRI

- Prone, no compression
- Contraindications
- Claustrophobia
- Contrast
- Cost

### Imaging as a science evolves

- Roentgen invented Xrays: 1895
- We had plain radiographs
- Linear Tomo
- CT
- MRI
- Molecular imaging: BSGI, PET
eg Renal imaging

plain film

Linear tomo scout
We need contrast

Most cancer imaging needs contrast
MRI most sensitive—uses contrast
But costly and time consuming
Cancer Imaging - eg Brain

Precontrast

Postcontrast
<table>
<thead>
<tr>
<th><strong>Contrast mammography?</strong></th>
<th><strong>Dedicated breast CT</strong></th>
<th><strong>Dedicated breast CT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Good idea but ....</td>
<td>• Better for dense breasts</td>
<td>• One &quot;view&quot;/acquisition (10 sec 360 degree)</td>
</tr>
<tr>
<td>• Upright patient</td>
<td>• Contrast ready</td>
<td>• Contrast ready</td>
</tr>
<tr>
<td>• Still Need 2 views per side</td>
<td>• Can reduce recalls - BIRADS 0</td>
<td>• May substitute for MRI</td>
</tr>
<tr>
<td>• One side at a time</td>
<td>• Reduce need for ultrasound - BIRADS 0</td>
<td>• More comfortable</td>
</tr>
<tr>
<td>• Compression may affect vascular</td>
<td>• Reduce short interval follow ups - BIRADS 3</td>
<td>• Less costly</td>
</tr>
<tr>
<td>• Timing</td>
<td>• Reduce number of biopsies - BIRADS 4</td>
<td></td>
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</tbody>
</table>
Capabilities of CBCT

- Good for dense (4-6x risk of dense vs fatty)
- Good for calcs - standard res. 0.273 mm
  - hi res. 0.122 mm
- Microcalcs <0.5mm-0.1mm
- Good for masses

Examples - dense

- Screening with small cancer
Dense with asymmetry

- BIRADS 0

- Is it real?
Work up

• Spot CC, spot MLO, 90 degree lateral
• Ultrasound
• So, which quadrant?

Birads 0 trans

Birad 0-sag
Final

- Negative - not real
- "False positive" mammogram

This one is real

- But which quadrant?
**Palpable mass**

- 4 mammo views-CC,MLO tan mag and 90
- targeted ultrasound
- CT one “view”
“Extent of disease” evaluation

- Compare with MRI
• Contrast

• Implants

Something different
Routine screening with Implant

- CC, MLO
- ID views-CC,MLO
- Add tomo?
Example: CT vs MRI

- Occult cancers:
- After diagnosis or high risk screen
- Cost x10
- Both prone
- Both iv
- MRI 40 mins table time CBCT ~10 mins

CE-CBCT vs MRI

Case 2: 45 yr/o female presents with left breast lump at 6:00 position
Stereo core biopsy:

MRI
CE-CBCT Pre contrast
CE-CBCT Post contrast

CE-KBCT correlates well with MRI but with higher resolution and more detail

Resolution of MRI

- 3T: in plane spatial resolution can be 0.8mm x0.8mm
  Slice thickness down to 1.8 mm
- 1.5T: Spatial res can be 1.03x1.03mm
  Slice thickness down to 2mm
- CBCT: isotropic 0.273mm down to 0.155mm
More…

- Biopsy capability - accurate targeting of asymmetry
- Evaluate vasculature around tumors

3D volume rendering of a breast illustrating a fibroadenoma and blood vessels as small as ~1 mm without IV contrast. Images have different Window/Level values to bring out different breast tissue densities.

Why do we need Breast CT?

- It’s better than mammogram
- Better than tomosynthesis
- At least as good as MRI
- It is the latest in the evolution of breast imaging for breast cancer
40,000 women need us