CBCT for Prone Breast

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Nash Cancer Treatment Center
Disclosures

• No outside funding or support
Disclosures

• Techniques likely apply across vendors
Prone Breast Technique
Rationale for Prone Breast
• Several studies have documented the benefits of prone setup for breast irradiation.
Prone position breast irradiation

Merchant, T., and McCormick, B.

• “Irradiation of the heart, lungs, chest wall and contralateral breast are minimized with this technique.”
Prone position breast irradiation

Merchant, T., and McCormick, B.

• “The improvements appear to benefit women with large breasts, pendulous breasts, large separations and/or irregularly shaped chest contours.”
Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry
Kirby, A., et al.

- Prone positioning reduced ipsilateral-lung mean
  - 65/65 WBI
  - 61/65 PBI cases
Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry
Kirby, A., et al.

- Prone positioning reduced heart and LAD doses
  - 19/30 WBI cases
  - 7/30 PBI cases
Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry
Kirby, A., et al.

- However, prone positioning increased cardiac doses
  - 8/30 WBI cases
  - 19/30 PBI cases
Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry
Kirby, A., et al.

• “In the context of tangential-field WBI and PBI, prone positioning is likely to benefit left-breast-affected women of larger breast volume, but to be detrimental in left-breast-affected women of smaller breast volume.”
Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry
Kirby, A., et al.

- “Right-breast-affected women are likely to benefit from prone positioning regardless of breast volume.”
Long-term Clinical Outcomes of Whole-Breast Irradiation Delivered in the Prone Position

• 245 women treated with prone breast board between 1992 and 2004
“Prone position breast radiation results in similar long-term disease control with a favorable toxicity profile compared with standard supine tangents.”
Rationale for Prone Breast

- Improves cosmesis
- Reduces lung dose
- Reduces heart dose (for large breasts)
- Reduces intra-fraction motion from breathing
Clinical Challenges
Prone Position: Panacea for Large Breast Treatment?
Not exactly…
Consistent Setup
Consistent Setup

- Our initial prone patients exhibited large inter-fraction variability:
  - New technique for therapists
  - Patients often overweight
Consistent Setup

- Our initial prone patients exhibited large inter-fraction variability:
  - Leveling marks not very useful
  - Isocenter on soft tissue
Intra- and Inter-fractional Variations for Prone Breast Irradiation: An Indication for Image-Guided Radiotherapy
Morrow, N., et al.

- Prone setup reduced intra-fractional variation (respiratory motion)
Intra- and Inter-fractional Variations for Prone Breast Irradiation: An Indication for Image-Guided Radiotherapy
Morrow, N., et al.

• However they found large inter-fractional variations
Intra- and Inter-fractional Variations for Prone Breast Irradiation: An Indication for Image-Guided Radiotherapy
Morrow, N., et al.

• “indicates the importance of image guidance for partial breast irradiation in the prone position”
Consistent Setup

- In our clinic, kV port films were insufficient to solve setup issues.
Consistent Setup

- CBCT provided the extra information needed to achieve more consistent setups
Planning CT
Planning CT

80 cm clearance
Planning CT

60 cm image
Gantry Clearance
Isocenter on breast is difficult for CBCT due to likely gantry collision
Center table laterally for imaging (with known shift back to treatment position)
Avoid use of wedges and accessories that might interfere with patient clearance
No “horse shoe”
Replace wedges with FinF if dose shaping required
Time Considerations

- About one minute to acquire CBCT
- Another couple of minutes to analyze and discuss
- Can easily add five minutes to overall treatment time
Dose Considerations
ALARA CBCT Technique

- Existing CBCT modes can be copied and changed
ALARA CBCT Technique

- Changing the mAs does not require recalibration
- Dose is directly proportional to mAs
ALARA CBCT Technique

- Modify pre-defined CBCT technique most appropriate for prone breast.
Full Fan Acquisition

Physical aperture: 83 cm

~18 cm
~25 cm diameter
Reconstructed Volume
Half Fan Acquisition

- Physical aperture: 83 cm
- ~16 cm
- 45 cm diameter
- Reconstructed Volume
Bow-Tie Filter

- Reduces dose
- Improves image quality
Bow-Tie Filter

- **Full** bow-tie filter
- **Full** fan acquisition modes
Bow-Tie Filter

- **Half** bow-tie filter
- **Half** fan acquisition modes
<table>
<thead>
<tr>
<th></th>
<th>Standard-Dose Head</th>
<th>Low-Dose Head</th>
<th>High-Quality Head</th>
<th>Pelvis</th>
<th>Pelvis-Spot light (Full Fm Fan Bow-Tie Filter)</th>
<th>Pelvis-Spot light (Half Fan Bow-Tie Filter)</th>
<th>Low-Dose Thorax</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Ray Voltage [kVp]</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>126</td>
<td>125</td>
<td>125</td>
<td>110</td>
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<tr>
<td>X-Ray Current [mA] per Projection</td>
<td>20</td>
<td>10</td>
<td>80</td>
<td>80</td>
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<td>X-Ray Millisecond [ms] per projection</td>
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<tr>
<td>Gantry Rotation Range [degrees]</td>
<td>200</td>
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<tr>
<td>Number of Projections</td>
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<td>655</td>
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<tr>
<td>Exposure (mAs)</td>
<td>145</td>
<td>72</td>
<td>720</td>
<td>680</td>
<td>720</td>
<td>720</td>
<td>262</td>
</tr>
<tr>
<td>CTDI_{w, norm} (mGy / 100 mAs)</td>
<td>2.7</td>
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<td>2.6</td>
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<td>3.4</td>
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<td>24.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Fan Type</td>
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<td>Default Pixel Matrix</td>
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<tr>
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<td>Ring Suppression Algorithm</td>
<td>Medium</td>
<td>Medium</td>
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Table 1: Pre-defined CBCT modes installed with OBI Advanced Imaging (CTDI_{w} and CTDI_{w, norm} values are ± 10%).
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Low Dose Thorax
(Varian Pre-Defined CBCT Mode)

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<th>CBCT Mode</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Mode</td>
<td>Low-dose thorax</td>
</tr>
<tr>
<td>Name</td>
<td>Example of a Clinical Mode</td>
</tr>
<tr>
<td>Title</td>
<td></td>
</tr>
<tr>
<td>Assoc. Disease</td>
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<tr>
<td>Mode Type</td>
<td>Clinical mode</td>
</tr>
<tr>
<td>Topogram Acquisition</td>
<td>Single image</td>
</tr>
<tr>
<td>Pulse Control</td>
<td>Pulse control by IAS</td>
</tr>
<tr>
<td>Intended Fan Type(s)</td>
<td>Half Fan</td>
</tr>
<tr>
<td>SID</td>
<td>150.0 cm</td>
</tr>
<tr>
<td>Number of Projections</td>
<td>650</td>
</tr>
<tr>
<td>Gantry Rtn. [deg/s]</td>
<td>6</td>
</tr>
</tbody>
</table>
Low Dose Thorax
(Varian Pre-Defined CBCT Mode)
Low Dose Thorax
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<th>Parameter</th>
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<tr>
<td>X-Ray Voltage [kV]</td>
<td>110</td>
</tr>
<tr>
<td>X-Ray Current [mA]</td>
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<td>X-Ray Millisecond</td>
<td>20</td>
</tr>
<tr>
<td>Pulse Mode</td>
<td>Single pulse</td>
</tr>
<tr>
<td>Tube Focus Type</td>
<td>Large focus</td>
</tr>
<tr>
<td>Physical Filter</td>
<td>Bow tie</td>
</tr>
<tr>
<td>Scatter Grid</td>
<td>Grid 10:1</td>
</tr>
<tr>
<td>Use Copper</td>
<td>False</td>
</tr>
</tbody>
</table>
Very Low Dose Thorax
(Modified CBCT Mode)
Very Low Dose Thorax
(Modified CBCT Mode)

- Tube current reduced from 20 mA to 10 mA
- CTDI\textsubscript{w} should lower from 4.7 mGy to 2.4 mGy
Very Low Dose Thorax
(Modified CBCT Mode)

<table>
<thead>
<tr>
<th>CBCT</th>
<th>Orthogonal MV Port Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose</td>
<td></td>
</tr>
<tr>
<td>0.2 - 0.3 cGy</td>
<td>2 - 4 cGy</td>
</tr>
<tr>
<td>(estimated from CTDI\textsubscript{w})</td>
<td>(very rough estimate assuming 2 - 4 MU)</td>
</tr>
</tbody>
</table>
Image Quality Effects
10 mA
Image Quality Effects
Image Quality Effects
10 mA
Case Study
Key Points

- A very low dose CBCT technique was developed to address inter-fraction setup variability for prone breast patients.
Key Points

• Patients were imaged daily (as needed), target volumes were compared in 3D (actual versus planned), shifts were automatically applied, and setup problems were readily visible and corrected if significant.
Key Points

• Low image dose and reduced image quality were acceptable as the breast contour, tumor bed, lung interface, and ribs were easily visible.
Key Points

• Over time our therapists and patients became acclimated to prone setup and the frequency of CBCTs was reduced.
Nash Cancer Treatment Center Colleagues
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