“Accurate boost” or Simply Accuboost
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Disclosure: Advisory board

Items to be discussed
- Technology
- Clinical reasons for such technology
- Dosimetry
- Comparison with Electrons and 3D-CRT
- Acceptance testing
- Clinical cases
- Questions

Big picture on management of Breast Cancer
Accubooost System components

- Mammography unit
- CR for films
- Overlays for Tx field
- Applicators
- HDR unit.
- Nomogram for Tx time

Treatment system setup

Why Mammography? undeniably, the best method to image/localize the lumpectomy site. “Gold Standard”

An alphanumeric radiopaque grid built into the paddle for applicator location.
Applicators (Tungsten)

- D-applicators: 5x66, 3x78 and 6x88 mm
- Round Applicator: 4, 5, 6, 7, 8

Advantage of D-applicator

Applicator and source path

Patient in treatment setup
Dosimetry of Accuboost

- MCNP5 based
- Work of Mark Rivard Ph.D.
- Breast Thicknesses from 30 to 80 mm
- Applicators Ranging from 40 to 80 mm
- All materials accurately modeled, including ICRU 44 Breast Tissue definition, not solid water analog

(Med Phys 36(11) 5027—5032)

Monte Carlo Data – Transverse Dose-Depth Distribution - Single Side

Monte Carlo Data – Single Axis Radial Dose Distribution
When treating an APBI patient with 4 opposed fields (perpendicular), the skin dose in relation to the prescribed dose is expected to be:

1. 120%
2. 50%
3. 100%
4. 70%
The D-Applicator is used for the following reason:

1. Appropriate geometrical dose coverage
2. The advantage of the dose distribution
3. The better access to lumpectomy cavity close to the chest wall
4. Shorter treatment time

Resulting dose distribution from four fields

Resulting Dose distribution for an Offset lesion
**Reasons for the technology**

- Reduce Dose to the heart and lung
- Less dose to surrounding normal tissue
- Conformal and Uniform Dose to target
- No geometric miss, excellent localization
- Ability to incorporate surgical and pathological information with respect to “margin at risk”. This leads to great flexibility in target design such that the boost can be as precise as a “targeted re-excision”
- Lower skin, rib and pectoralis muscle dose
- Non-Invasive technology
- Easy to implement and use

**Reduction of dose to heart and lung**

*Conventional Electron Boost – 50% isodose line grazes the lung & 50% isodose line penetrates deeply into the chest cavity.*

*AccuBoost – The 10% isodose line barely penetrates the chest cavity.*

**Electrons vs. Accuboost**

Electrons – APBI =>

AccuBoost <= APBI =>
### Electrons vs. Accuboost

<table>
<thead>
<tr>
<th></th>
<th>PTV vol (%)</th>
<th>PTV V100 (%)</th>
<th>PTV V95 (%)</th>
<th>PTV D90 (Gy)</th>
<th>PTV D95 (Gy)</th>
<th>PTV D99 (Gy)</th>
<th>PTV Dmin (Gy)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuboost Median</td>
<td>58 (54–60)</td>
<td>54.2 (50.2–58.2)</td>
<td>57.1 (53.5–62)</td>
<td>54.4 (51.6–57.1)</td>
<td>57.2 (54.3–60.3)</td>
<td>54.4 (51.6–57.1)</td>
<td>2.7 (2.2–3.4)</td>
<td>NS</td>
</tr>
<tr>
<td>Electron Median</td>
<td>12 (9.2–16.6)</td>
<td>15.1 (13.0–15.5)</td>
<td>19.6 (16.8–21.6)</td>
<td>17.8 (16.0–19.6)</td>
<td>21.1 (18.3–23.7)</td>
<td>17.8 (16.0–19.6)</td>
<td>2.1 (1.8–2.5)</td>
<td>NS</td>
</tr>
<tr>
<td>p-value</td>
<td>0.04</td>
<td>NS</td>
<td>0.04</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>0.005</td>
</tr>
</tbody>
</table>

**Summary of comparison**

- Accuboost median max skin dose is 25% lower than electron boost and 10% less than 3D-CRT.
- Accuboost delivers 70-80% less dose to the chest wall and lungs.
- PTV coverage is comparable between the techniques.
- There is NSS difference between electron boost and Accuboost boost for the V110, Dmax, Dmean, or D90.
- Electron boost plans have a lower median Dmin than Accuboost boost (1.0 Gy vs. 1.8 Gy, p=0.039), but higher V100 and D50.
- The only significant difference between the APBI techniques is slightly higher median D90 with 3DCRT (97.4% vs 93.4%, p=0.016) and higher Dmax with Accuboost (45.4 Gy vs. 40 Gy, p=0.055).
One of the major advantages of Accuboost over 3D external beam is:

- 25% 1. The dose reduction to the chest wall
- 25% 2. The dose reduction to the lung
- 25% 3. The dose reduction (maximum dose) to the skin
- 25% 4. All the above

Geometric miss? Boost setup:
- CT imaging
- U/S imaging
- Clips
- Scars
- Others

CT OPTION (Electron and 3D CRT)
- Clinical setup with CT not accurate
- Geometric miss
**U/S Option (External beam)**

Princess Margaret study:
- 54 pts had U/S boost loc
  1) 65% had the clips inside the boost field
  2) 28% marginal
  3) 7% inadequate (clips outside U/S field)


**Clips option**

- Not easily visible in U/S
- Obvious with Mammography
- Good reference for cavity identification and delineation: very helpful

**Scar option**

- Alone not reliable for cavity identification
- Red: scar
- Light blue: Cavity
- Green: electron field


**Accuboost option**

- Mammography used to localize target
- Breast is immobilized with compression
- No margin of error
- Breathing motion eliminated
- No target movement during treatment
Acceptance testing for Accuboost

- Dose profiles and distributions with films (Gafchromic Film)
- Verification of Applicators sizes, connections, dwell points
- Output factor (Gy/min)
- Verification of Treatment time
- Plate Separation (compression thickness)
- Applicator Catheters (inspection and replacement)
- Training for staff (therapists, dosimetrists) for the use and interpretation of the Mammo. unit
- Mammography & CR Systems
  - Calibrated on Site by Mammography system installer
  - Form DD2579 filed with the state by ART, not for mammography but for localization only
  - Typically - Facility adds one radiation emitting device to its license and monitoring protocols

Dosimetry: single field

Opposed field

D-Applicator
Dose Distribution - Gafchromic Film D60

Transverse Dose Distribution
Short Axis

Planar Dose Distribution
3 cm depth
### Output verification

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>O.F. Output factor</th>
<th>Output reading (C)</th>
<th>Detection limit</th>
<th>Number</th>
<th>Tatum dwell time (sec)</th>
<th>Number of dwell points</th>
<th>Activity (Ci)</th>
<th>Applicator (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1</td>
<td>3</td>
<td>4.084</td>
<td>4.064</td>
<td>0.04</td>
<td>5.32</td>
<td>2.1</td>
<td>10.24</td>
<td>4.5</td>
</tr>
<tr>
<td>Round 2</td>
<td>3</td>
<td>4.084</td>
<td>4.064</td>
<td>0.04</td>
<td>6.27</td>
<td>2.1</td>
<td>10.24</td>
<td>4.5</td>
</tr>
<tr>
<td>Round 3</td>
<td>3</td>
<td>4.084</td>
<td>4.064</td>
<td>0.04</td>
<td>7.27</td>
<td>2.1</td>
<td>10.24</td>
<td>4.5</td>
</tr>
</tbody>
</table>

### Setup for clinical cases

- Typical setup Cranio-caudal
- Same patient Medio-lateral

### Selection of applicators

- Cranio-caudal 6 cm applicator
- Medio-lateral 5 cm applicator

### Exclusion for Accuboost

- Cavity too large
- Patients cannot tolerate compression
- Cavity not easily identified
- Cavity too close to chest wall (even with D applicators)
Accubooost treatment

- Prior to external beam: easier on patients
- Possibility of discomfort if too close to post-op.
- Half way through the external beam: possibility of discomfort (?)
- Boost one or two days per week within the course of WBP

Treatment time calculation

- Based on Monte Carlo (MCNP version 5) simulation
- Backed by calibrated NIST traceable ionization chamber measurements
- For 4-8 cm diameter applicators
- For 3-8 cm thick breast
- Options for breast tissue or polystyrene

Treatment time calculation: use of nomogram

Round Appliculator Treatment Nomogram

<table>
<thead>
<tr>
<th>Patient name</th>
<th>Radiation #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10/20/2008</td>
</tr>
<tr>
<td>Treatment date</td>
<td>2 of 5</td>
</tr>
<tr>
<td>Setup location</td>
<td>1.5</td>
</tr>
<tr>
<td>Mammography site</td>
<td>40</td>
</tr>
<tr>
<td>Applicator size [mm]</td>
<td>50</td>
</tr>
<tr>
<td>Source strength [SI]</td>
<td>50.00</td>
</tr>
<tr>
<td>Plate separation [mm]</td>
<td>20</td>
</tr>
<tr>
<td>Percent isocenter line [V-100%]</td>
<td>100%</td>
</tr>
<tr>
<td>Prescription breast dose [Gy] per fraction</td>
<td>140.00</td>
</tr>
<tr>
<td>C-10 dose rate [Gy/H]</td>
<td>17.00</td>
</tr>
<tr>
<td>Treatment time [Calculate]for 2 calculations</td>
<td>5.92</td>
</tr>
</tbody>
</table>
### Treatment time calculation

- Number of dwell points: 3 x applicator size for round one
- Different for D-applicators
- All dwell points should be used
- Step size equal 1 cm
- Source indexer 1500 mm for Nucletron system

### Acknowledgements

- Ray Bricault, ART
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### Questions??