Bilateral Breast Cancer: A Challenging Task in Radiation Therapy

Presented by Karen Long, CMD, MRT (T)
Tom Baker Cancer Centre
Calgary, Alberta Canada
Nothing to Disclose
1. 3D CRT planning technique used to treat bilateral chest wall plus RNI including bilateral IMNs

2. Controversy in radiotherapy for patients with synchronous bilateral breast cancers and comprehensive RNI
International practices: review of a dosimetrists’s survey

Bilateral Breast Cancer: A Challenging Task in Radiation Therapy

Synchronous, bilateral breast cancer: prognostic value and incidence.

Johansen J1, van der Palen J, Ong F, Meerwaldt JH
Dosimetric Planning Techniques for Bilateral Breast Cancer Survey
Tom Baker Cancer Centre

Best practice for patients with bilateral breast cancers?

Evidence for Breast Cancer Nodal RT

- **MA20**_Regional Nodal Irradiation (RNI) in Early-Stage Breast Cancer
- **EORTC 22922**_Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer
- **DBCG-IMN**_A Population-Based Cohort on the Effect of Internal Mammary Node (IMN) Irradiation in Early Node-Positive Breast Cancer
In general, if a patient with breast cancer is treated with RNI at your center, would the IMNs be included in the target volume?

- Yes: 61%
- No: 39%
Is there a trend based on geographic regions as to whether IMNs are included in RNI?

<table>
<thead>
<tr>
<th>Region</th>
<th>Total Respondents (n = 135)</th>
<th>Centers irradiating IMNs (n = 82)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>96</td>
<td>58 (60%)</td>
</tr>
<tr>
<td>Europe</td>
<td>17</td>
<td>11 (65%)</td>
</tr>
<tr>
<td>Asia</td>
<td>9</td>
<td>5 (56%)</td>
</tr>
<tr>
<td>Oceania</td>
<td>8</td>
<td>4 (50%)</td>
</tr>
<tr>
<td>South America</td>
<td>5</td>
<td>4 (80%)</td>
</tr>
</tbody>
</table>
Literature Review

“This is the first study of bilateral breast with regional nodal irradiation. Radiotherapy for bilateral breast and regional lymph nodes is best achieved using IMRT due to its superior ability to cover the target volumes, while minimizing dose to organs at risk. Further studies will reveal if higher integral lung dose translates into clinically significant chronic toxicity given the excellent long-term survival in these patients.”
Evaluation of target and cardiac position during visually monitored deep inspiration breath-hold for breast radiotherapy

Leigh Conroy, 1, 2 Rosanna Yeung, 2 Elizabeth Watt, 1, 2 Sarah Quirk, 1, 2 Karen Long, 4 Alana Hudson, 1, 3 Tien Pham, 2 and Wendy L. Smith 1, 2, 3

Free Breathing  Deep Inspiration Breath Hold
Does your center use deep inspiration breath hold (DIBH) strategies to treat any breast cancer patients?

- Yes: 59%
- No: 41%

Does your center use a DIBH technique for patients receiving simultaneous bilateral chest wall/breast radiation therapy?

- Yes: 29%
- No: 63%
- Other: 8%
Low incidence

Small patient cohorts

Best practice?

DIBH?

No consensus

Challenging treatment planning

DOSIMETRIC COMPARISON OF 3D CONFORMAL RADIATION THERAPY (3DCRT) AND VOLUMETRIC ARC THERAPY (VMAT) IN PATIENTS WITH BILATERAL BREAST CANCER WITH INDICATIONS FOR ADJUVANT RADIATION

AAMD 43rd Annual Meeting
June 17 – 21, 2018
48 Year Old Woman
Bilateral Mastectomy and Axillary Dissection
Bilateral Chest walls, RNI and IMNs

Which technique describes the treatment planning method most commonly used for this patient, in your center?

- Static photon fields only (forward planned field-in-field, 3D CRT, etc.)
- Static photon(s) plus electron(s) fields (forward planned field-in-field, 3D CRT, etc.)
- IMRT step and shoot
- IMRT sliding window
- VMAT (RapidArc®, Tomotherapy®, etc.)
- Other: please specify
Technique (n = 64)

- VMAT: 41%
- 3D CRT P/E: 22%
- IMRT: 20%
- Others:
  - Photons only
  - IMRT step and shoot
  - VMAT
  - Protons
  - Photons plus electrons
  - IMRT sliding window
  - Electron Arc

FB vs DIBH for VMAT and 3D Photons/Electrons.
How many patients have received radiation therapy for bilateral synchronous breast cancer in your center in the last year?

- 1 to 5: 68%
- 6 to 10: 23%
- 11 to 15: 15%
- Over 15: 4%

Dose Dynamic: 61%

3D: 30%

Electron Arc: 61%

Protons: 61%
3D CRT Mono-Isocentric Photon
Plus Electron

Anterior Mid Chest Photon
3D CRT Mono-Isocentric Photon Plus Electron
3D CRT Mono-Isocentric Photon Plus Electron

1cm

125% 95% 50% 10%

Hot spot
Modulation as seen on the Skin Rendering

Field Summary = 8 Fields
7 Photon plus 1 Electron (9Mev)
3D Breath Holds (minimum)

3D Photon/Electron
• 3 practice breaths
• 3 verification images
• 4 skin markings
• 8 treatment fields

_____

= 18

Field Summary = 8 Fields
AP/PA Bilateral Supraventricular and
6 Conformal Arcs
Assessing number of ARCs and Delivery Time

<table>
<thead>
<tr>
<th>ARC</th>
<th>Average Gantry Speed</th>
<th>Degrees</th>
<th>~Delivery Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW1</td>
<td>5</td>
<td>90</td>
<td>18</td>
</tr>
<tr>
<td>CW2</td>
<td>5.5</td>
<td>91</td>
<td>17</td>
</tr>
<tr>
<td>CW3</td>
<td>5.5</td>
<td>137</td>
<td>25</td>
</tr>
<tr>
<td>CW4</td>
<td>4.5</td>
<td>136</td>
<td>30*</td>
</tr>
<tr>
<td>CCW1</td>
<td>5.5</td>
<td>90</td>
<td>16</td>
</tr>
<tr>
<td>CCW2</td>
<td>3.5</td>
<td>89</td>
<td>25</td>
</tr>
</tbody>
</table>

VMAT Breath Holds (minimum)

VMAT Hybrid
• 3 practice breaths
• 2 verification images
• 8 treatment fields

= 13
Organs at Risk: Lungs, Heart and Left Anterior Descending Artery (LAD)

DEVELOPMENT AND VALIDATION OF A HEART ATLAS TO STUDY CARDIAC EXPOSURE TO RADIATION FOLLOWING TREATMENT FOR BREAST CANCER

MARY FENG, M.D.,* JEAN M. MORAN, Ph.D.,* TODD KELLING, M.D.,† AAMER CHUGHIALI, M.D.,‡ JUNIS L. CICIN, M.D.,* LAURA FREEDMAN, M.D.,* JAMES A. HAYMAN, M.D.,* REEMA JASSI, M.D., D. PEEL,* SHRUTI JOLLY, M.D.,* JANICE LARCOEUR, M.D.,* JULIE SORIAO, M.D.,* ROBIN MARSH, C.M.D.,* and LORI J. PIERCE, M.D.*

DVH Plan Comparison

LAD_3D

Heart_3D

Lungs_3D

Bilateral IMNs

Chest wall

Target
NSABP B51 Dosimetric Criteria
Targets

<table>
<thead>
<tr>
<th>Structure</th>
<th>Dose Criteria</th>
<th>Variation Acceptable</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest wall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target_3D</td>
<td>95% Vol = 95% Dose</td>
<td>90% Vol = 90% Dose</td>
<td>95% Vol = 93.5% Dose</td>
</tr>
<tr>
<td>Chest wall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target_VMAT</td>
<td></td>
<td></td>
<td>95% Vol = 93.0% Dose</td>
</tr>
</tbody>
</table>

IMN_3D
<table>
<thead>
<tr>
<th>Structure</th>
<th>Dose Criteria</th>
<th>Variation Acceptable</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMN_3D</td>
<td>95% Vol = 90% Dose</td>
<td>90% Vol = 80% Dose</td>
<td>95% Vol = 81% Dose</td>
</tr>
</tbody>
</table>

IMN_VMAT
<table>
<thead>
<tr>
<th>Structure</th>
<th>Dose Criteria</th>
<th>Variation Acceptable</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMN_VMAT</td>
<td></td>
<td></td>
<td>95% Vol = 85% Dose</td>
</tr>
</tbody>
</table>

Please define how the IMN contour is drawn in your center?

<table>
<thead>
<tr>
<th>Answer Choices</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTOG Guideline</td>
<td>68%</td>
</tr>
<tr>
<td>EORTC Guideline</td>
<td>9%</td>
</tr>
<tr>
<td>N/A</td>
<td>14%</td>
</tr>
<tr>
<td>Other</td>
<td>9%</td>
</tr>
</tbody>
</table>

What is your center’s IMN dose metric?

V95%, V90%, V80%, n/a, other
### NSABP B51 Dosimetric Criteria

#### Heart

<table>
<thead>
<tr>
<th>Structure</th>
<th>Dose Criteria</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart (10%)_3D</td>
<td>≤ 25 Gy</td>
<td>9.74 Gy</td>
</tr>
<tr>
<td>Heart (10%) VMAT</td>
<td>10.80 Gy</td>
<td>✔</td>
</tr>
</tbody>
</table>

#### Heart Mean

<table>
<thead>
<tr>
<th>Structure</th>
<th>Dose Criteria</th>
<th>Variation Acceptable</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Mean_3D</td>
<td>≤ 4 Gy</td>
<td>≤ 5 Gy</td>
<td>5.1 Gy</td>
</tr>
<tr>
<td>Heart Mean VMAT</td>
<td></td>
<td></td>
<td>5.6 Gy</td>
</tr>
</tbody>
</table>

### Dose Comparison

#### Left Anterior Descending Artery (LAD)

<table>
<thead>
<tr>
<th>Structure</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAD Maximum 3D</td>
<td>11.87 Gy</td>
</tr>
<tr>
<td>LAD Maximum VMAT</td>
<td>15.50 Gy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structure</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAD Mean_3D</td>
<td>6.30 Gy</td>
</tr>
<tr>
<td>LAD Mean VMAT</td>
<td>10.8 Gy</td>
</tr>
</tbody>
</table>
In your center is the LAD contoured?

Does your center have an LAD dose constraint for breast cancer patients?

- LAD Mean
- LAD Maximum
- Heart Dose Maximum
- Other

- Yes
- No

- 35%
- 20%
- 15%
- 30%
Is any lung dose constraint evaluated for bilateral breast cancer patients that is not routinely evaluated for unilateral breast patients?

Yes

No

Most common dose constraint: V20 ≤ 20% - 30%
### Dosimetric Criteria “Maximum Dose”

<table>
<thead>
<tr>
<th>Maximum Point Dose = 0.03cc</th>
<th>NSABP B51 Dose Criteria</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D</td>
<td>≤ 125%</td>
<td>120%</td>
</tr>
<tr>
<td>VMAT</td>
<td>N/A</td>
<td>112%</td>
</tr>
</tbody>
</table>

- **Dosimetric Criteria**
  - **“Maximum Dose”**
  - **Chest wall Target**
  - **IMN Target**
  - **Heart 10%**
  - **Heart Mean**
  - **LAD**
  - **Lung V20**
  - **Lung V10**
  - **Lung V5**
  - **Monitor Units**

<table>
<thead>
<tr>
<th>3D</th>
<th>VMAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1232</td>
<td>1235</td>
</tr>
</tbody>
</table>
Dosimetric Comparisons

3D Photons and Electrons

VMAT

Anatomical advantage from DIBH

Time required for Unilateral and Bilateral Breast Treatment Planning (respondents irradiating IMNs)

<table>
<thead>
<tr>
<th>Time Range</th>
<th>Unilateral Plan Time</th>
<th>Bilateral Plan Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>LESS THAN 2 HOURS</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>2 HOURS TO 0.5 DAY</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>0.5 TO 1.0 DAY</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>GREATER THAN 1.0 DAY</td>
<td></td>
<td>38</td>
</tr>
</tbody>
</table>
Treatment Appointment Time Scheduled in the Second Week of Treatment

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>IMRT</th>
<th>3D Photons/Electrons</th>
<th>VMAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35</td>
<td>37</td>
<td>27</td>
</tr>
</tbody>
</table>

Clinical Priorities

<table>
<thead>
<tr>
<th>Clinical Priority</th>
<th>Percentage ranking “Most Important” (n = 55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Coverage</td>
<td>69%</td>
</tr>
<tr>
<td>Integral Dose</td>
<td>5%</td>
</tr>
<tr>
<td>Dose Homogeneity</td>
<td>0%</td>
</tr>
<tr>
<td>Dose to Normal Tissues</td>
<td>26%</td>
</tr>
</tbody>
</table>
Conclusions and Future Work

Thank You!
Acknowledgements

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Darren Graham

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Nils Bergman

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