Regional Nodal Irradiation in the Prone Position for Node Positive Breast Cancer

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Contributing Co-Authors: Karla Kuhn CMD; Sasha Beyer, MD, PhD; Dominic DiCostanzo, MS; Jose Bazan, MD; Julia White, MD

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Disclosures

- No disclosures relative to the presented material
- The following presentation is a reflection of studies, protocols, and opinions
- No Honorarium has been received in regards to the subsequent material
- Eclipse v.13.6
Meet the Speaker

Lee Culp, M.S CMD RT(T)
- Dosimetrist at OSU – SSCBC
- Co-Chair AAMD CEC
- Originally from Buffalo, NY
- Masters in Dosimetry from University of Wisconsin – La Crosse
- Loves being on the water, and his three kids – Maximus, Luna, and Stella

Meet the Speakers

Erin Healy, MD
- 4th year Resident in Radiation Oncology at The Ohio State University
- Originally from Los Angeles, California
- Bachelors Degree in Biology from University of California, San Diego
- Masters in Medical Sciences from Loyola University Chicago
- Medical School at University of California, Davis
- Interested in Breast Cancer and Survivorship
Third largest cancer hospital in the nation
- 21 stories
- 1.1 million square feet
- 306 inpatient beds, including 36-bed BMT unit
- 140 ICU beds
- 14 operating rooms
- 6 interventional radiology suites
- 7 linear accelerators for Radiation Oncology
- Dedicated early-phase clinical trials unit
- Opened December 14th 2014

The “New” James Cancer Hospital
- Opened December 2014
- All disease sites except Breast

Stefanie Spielman Comprehensive Breast Center - SSCBC
- Opened January 2011
- All Breast and Breast metastasis
Our Clinic

The Stefanie Spielman Comprehensive Breast Center (SSCBC) at the Ohio State University

Opened January 2011

Overview

Evolution
Background
CT Simulation
Planning
Methods
Results
Conclusion
Overview

Evolution

Background

CT Simulation

Planning

Methods

Results

Conclusion

Breast Cancer Epidemiology

- Most commonly diagnosed cancer among women
- 182,000 women diagnosed annually in the US
- ~41,000 women die of Breast Cancer annually
- Second leading cause of cancer death among women after lung cancer
- Lifetime risk of dying from Breast Cancer 3.4%
Evolution of Surgical Treatment

- First known, documented cases patients either did nothing or had barbaric surgeries (Ancient times)
- Halsted Radical Mastectomy (late 1890s-1970s)
- Modified Radical Mastectomy (1970s – early 2000s)
- Lumpectomy (2000s - )

Evolution of Surgical Treatment

- Pre Surgery Treatment??

  - Protocol OSU 13282:

    - Feasibility of assessing Radiation Response with MRI/CT Directed Pre-Op Accelerated Partial Breast Irradiation in the Prone Position for Hormone Response early stage Breast Cancer

Protocol OSU 13282

Sponsored by Susan G Komen Foundation
Evolution of Radiotherapy Breast Planning

Where did we come from?
Supine 2D – The Past
- Done by Simulator
- Borders marked visually by Physician with wire
- Half-beam blocked technique
- Gantry angle chosen from crossing of medial and lateral wires
- Standard of 2 cm of lung treated
- Used mobile contour plotter to achieve a 2D treatment plan

Evolution of Breast Planning at SSCBC

3D – The Present
- Free Breathing → DIBH → Prone
- Done by CT Simulator
- Border is marked visually by Physician with wires to use as a guide when contouring
- Dosimetrist contours Organs at Risk; MD contours target volumes
- Dosimetrist utilizes all 3D tools: Conformal, and if necessary, IMRT planning to achieve our Dosimetric goals
Benefits Prone Breast Radiotherapy

- Better dose homogeneity due to smaller separation
- Reduces skinfolds
- Distances the breast from the chest wall
- Reduction in chest wall motion

Indications for Prone Breast Radiotherapy

- Breast size is not necessarily an indicator for prone RT
- Left sided breast cancer patients to avoid the heart & lung
- Cases where maximal lung avoidance is desirable such as smokers, severe COPD, heart issues

Approximately 70% of patients at SSCBC undergoing post-lumpectomy breast radiotherapy are treated in prone position
Overview

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Background

Regional Nodal Irradiation in the Prone Position for Node Positive Breast Cancer

- For Breast Cancer (BC) patients with positive axillary nodal metastasis, irradiation of regional nodes in addition to the breast has demonstrated improved disease free survival in randomized control trials¹.

- Women with large pendulous breasts can be difficult to treat due to excess dose to organs at risk (OAR) and worse toxicity²,³.

- Prone positioning for breast radiation is used for node negative cases to improve outcome in this population⁴.

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Background

New ideas pass through three periods:
1) It can't be done;
2) It probably can be done, but it's not worth doing;
3) I knew it was a good idea all along!

~ Arthur C. Clarke

• There is limited experience with delivery of regional nodal irradiation (RNI) in the prone position.

• We sought to characterize the dosimetry and toxicity profile of breast/RNI in the prone position.
Patients Suitable for Prone Nodal Irradiation

SSCBC Guidelines for Prone Nodal Irradiation

- Lymph Node positive (fulfill basic criteria for RNI)
- Smoking History
- Age
- High BMIs
- Large Breast size

Standard Fractionation
2.0Gy * 25 FX = 50.0 Gy

Overview

Evolution
Background
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CT Simulation

Prone patient set-up

Scars and borders are wired.
Lasers are aligned mid-nipple.

CT Simulation

Patient set-up

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CT Simulation

Patient set-up

Contralateral breast is gently pulled inferiorly and laterally

Head is turned toward contralateral breast. Shoulders are relaxed. Back is flat as possible.

5 Tattoos

Ipsilateral Tattoo

Board number on index bar in line with mid-nipple or other designated breast mark
5 Tattoos (cont’d)

3 PA Tattoos

Contralateral Tattoo

Tricks & Tips

Sans Sponge

With Sponge

*Note the position of the contralateral Breast
Overview

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Planning

Prone Breast Planning at SSCBC

- Protocols used
- OAR & Targets
- Goals
RTOG 1005 & 1304

Organs at Risk
- Heart
- Left Lung
- Right Lung
- Contralateral Breast
- Sternum
- Thyroid

Physician Drawn Targets
- Breast CTV
- Breast PTV
- Breast PTV Eval
- Lumpectomy (Lump) GTV
- Lump CTV
- Lump PTV
- Lump PTV Eval

*In Prone (and Supine DIBH) at SSCBC the CTV to PTV expansion is reduced to 5mm due to limited chestwall motion

Targets Contoured:
- Lump GTV
- Lump CTV
- Lump PTV Eval
- IMC PTV
- Breast PTV Eval
- Breast CTV
- Axilla PTV
- SupClav PTV
Targets Contoured:

- Axilla PTV
- SupClav PTV
- Breast PTV Eval
- IMC PTV

Constraints & Goals

**RTOG 1005 & 1304**

<table>
<thead>
<tr>
<th>Ideal</th>
<th>Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast PTV Eval</td>
<td>95%/95%</td>
</tr>
<tr>
<td>Lump PTV Eval</td>
<td>95%/95%</td>
</tr>
<tr>
<td>SupClav PTV</td>
<td>95%/95%</td>
</tr>
<tr>
<td>Axilla PTV</td>
<td>95%/95%</td>
</tr>
<tr>
<td>IMC PTV</td>
<td>95%/90%</td>
</tr>
<tr>
<td>50% Breast PTV Eval</td>
<td>&lt;108%</td>
</tr>
<tr>
<td>VBreast Receiving Boost Dose</td>
<td>30%</td>
</tr>
<tr>
<td>Heart Mean</td>
<td>&lt;400cGy</td>
</tr>
<tr>
<td>Lung V20</td>
<td>30%</td>
</tr>
<tr>
<td>Contra Breast Max</td>
<td>3Gy&lt;5%</td>
</tr>
</tbody>
</table>

**SSCBC**

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<td>100%/100%</td>
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<td>SupClav PTV</td>
<td>95%/95%</td>
</tr>
<tr>
<td>Axilla PTV</td>
<td>95%/95%</td>
</tr>
<tr>
<td>IMC PTV</td>
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<td>&lt;108%</td>
</tr>
<tr>
<td>VBreast Receiving Boost Dose</td>
<td>30%</td>
</tr>
<tr>
<td>Heart Mean</td>
<td>&lt;300cGy</td>
</tr>
<tr>
<td>Lung V20</td>
<td>25%</td>
</tr>
<tr>
<td>Contra Breast Max</td>
<td>3Gy&lt;5%</td>
</tr>
</tbody>
</table>

*Boost (when indicated) & Whole Breast planned simultaneously in Prone Position. Constraints & Goals evaluated in Plan Sum.*
Prone Nodal Irradiation with Boost

- Boost is planned at time of Initial plan
- Boost is in Prone position as well
- “Simultaneous Boost” hotspot placed in the Lump PTV Eval
- Plan evaluated in Plan Sum
- “Ski slope”
  - V54

Prone Nodal Irradiation - Planning

- Where do we start?
- Attempted 3D
- Therapists unable to see match line
- Moved to Static IMRT Planning
- Which beam angles for IMRT??
Prone Nodal Irradiation ISO placement

- Ideally want in middle of ALL Volumes
- Due to use of Truebeams, we know what shifts to use for clearance
- Also must be mindful of RAILS
  - RAILS OUT are more reliable and reproducible than RAILS IN
  - Need clearance of ~37cm from rail to ISO

Planning OSU 13282

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Prone Nodal Irradiation Beams Used

Prone Nodal Irradiation - Optimization
Prone Nodal Irradiation - Planning

- Met ideal constraints and objectives per 1304
- 9 field static IMRT

Prone breast/RNI treatment plan

Supraclavicular (SCL) coverage

Internal mammary chain (IMC) coverage

Cardiac avoidance
Prone Nodal Irradiation - Planning
Prone Nodal Irradiation - Planning

Lumpectomy **Boost** 3D conformal

LPO  
RPO

Prone Nodal Irradiation - Planning

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VSim & Treatment Setup

- Patient adjusted Right to Left, Sup and Inf, and rolled to align tattoos to lasers.

PA and Lateral SSD is checked

---

Prone Nodal Irradiation - Imaging

- Always performed with physician present
- Orthogonal kV pairs taken for isocenter verification
- Shifts made (if necessary)
- CBCT taken to finalize isocenter verification
- PA, lateral, and treatment SSDs are verified
Prone Nodal Irradiation - Orthog’s

- kV PA Setup
- kV LLat Setup

Prone Nodal Irradiation - CBCT

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# Methods

- Thirteen cases of prone positioned breast/RNI were identified between 2014 and 2017.

- Target (CTV and PTV) and OAR volumes contoured on each case include: Lumpectomy (PTV lump eval), Breast (PTV breast eval), Axilla (PTV Ax), Supraclavicular (PTV SCL), Internal mammary nodes (PTV IMC), heart, bilateral lungs, and contralateral breast.

- Dose was 50Gy in 25 fractions, delivered with inversed planned IMRT (median fields 8; range 8-10) with 6MV photons using the OAR constraints outlined in NSABP B51/RTOG1304 clinical trial.

- A sequential PTV lump boost was delivered in 12 patients (92.3%) with 3DCRT; doses were 10Gy in 4 (33.3%), 12Gy in 4 (33.3%), 14Gy in 3 (25%) and 16Gy in 1 (8.3%).
Overview

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Results

• Most patients (92.3%) had BMIs ≥30 kg/m²
• Mean breast volume was 1888.0 cc

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>58</td>
<td>60</td>
<td>39 – 70</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>38.8</td>
<td>36.5</td>
<td>22.75 – 51.9</td>
</tr>
<tr>
<td>Breast Volume (cc)</td>
<td>1888.0</td>
<td>1883.0</td>
<td>970.3 – 2698.4</td>
</tr>
</tbody>
</table>
Results

- Most patients (61.5%) were African-American
- Most patients had multiple co-morbidities
- Approximately half of the patients were current or former smokers

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>N</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>3</td>
<td>23.0</td>
</tr>
<tr>
<td>African American</td>
<td>8</td>
<td>61.5</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>15.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Co-morbidities</th>
<th>N</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>5</td>
<td>38.5</td>
</tr>
<tr>
<td>Hypertension</td>
<td>12</td>
<td>92.3</td>
</tr>
<tr>
<td>COPD/asthma</td>
<td>4</td>
<td>30.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Smoking status</th>
<th>N</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>7</td>
<td>53.8</td>
</tr>
<tr>
<td>Former</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td>Current</td>
<td>4</td>
<td>30.8</td>
</tr>
</tbody>
</table>

- Most patients (61.5%) were African-American
- Most patients had multiple co-morbidities
- Approximately half of the patients were current or former smokers

<table>
<thead>
<tr>
<th>Laterality</th>
<th>N</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>7</td>
<td>53.8</td>
</tr>
<tr>
<td>Left</td>
<td>6</td>
<td>46.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage</th>
<th>N</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIA</td>
<td>1</td>
<td>7.7</td>
</tr>
<tr>
<td>IIB</td>
<td>4</td>
<td>30.8</td>
</tr>
<tr>
<td>IIIA</td>
<td>5</td>
<td>38.5</td>
</tr>
<tr>
<td>IIIB</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IIIC</td>
<td>2</td>
<td>15.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hormone receptor status</th>
<th>N</th>
<th>(%)</th>
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</thead>
<tbody>
<tr>
<td>ER+/PR-/Her2-</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td>ER+/PR+/Her2-</td>
<td>6</td>
<td>46.2</td>
</tr>
<tr>
<td>ER+/PR+/Her2+</td>
<td>1</td>
<td>7.7</td>
</tr>
<tr>
<td>ER-/PR+/Her2+</td>
<td>1</td>
<td>7.7</td>
</tr>
<tr>
<td>ER-/PR-/Her2-</td>
<td>3</td>
<td>23.0</td>
</tr>
</tbody>
</table>

- Most patients (69.2%) had either stage IIB or IIIA disease
- Most tumors (61.5%) were hormone-receptor positive and Her2 negative
Results

- Most patients (53.8%) were treated with neoadjuvant chemotherapy
- Most patients (76.9%) underwent an axillary lymph node dissection (ALND)

<table>
<thead>
<tr>
<th></th>
<th>N (%)</th>
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<tbody>
<tr>
<td>Neoadjuvant Chemotherapy</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>6 (46.2)</td>
</tr>
<tr>
<td>Yes</td>
<td>7 (53.8)</td>
</tr>
<tr>
<td>ALND</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3 (23.1)</td>
</tr>
<tr>
<td>Yes</td>
<td>10 (76.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNs Removed</td>
<td>20</td>
<td>1 - 46</td>
</tr>
<tr>
<td>LNs Positive (pathologically)</td>
<td>4</td>
<td>0 - 46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Target Structure</th>
<th>Constraint Volume</th>
<th>Left (n=6) cGy</th>
<th>Right (n=7) cGy</th>
<th>All (n=13) cGy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTV Breast Eval</td>
<td>V95%**</td>
<td>4940</td>
<td>4800</td>
<td>4860</td>
</tr>
<tr>
<td></td>
<td>V90%**</td>
<td>5050</td>
<td>4920</td>
<td>4980</td>
</tr>
<tr>
<td>PTV Lump Eval</td>
<td>V95%*</td>
<td>6220</td>
<td>5680</td>
<td>6030</td>
</tr>
<tr>
<td></td>
<td>V90%**</td>
<td>6300</td>
<td>5620</td>
<td>6100</td>
</tr>
<tr>
<td>PTV Ax</td>
<td>V95%*</td>
<td>4910</td>
<td>4750</td>
<td>4820</td>
</tr>
<tr>
<td></td>
<td>V90%**</td>
<td>5020</td>
<td>4820</td>
<td>4910</td>
</tr>
<tr>
<td>PTV SCL</td>
<td>V95%*</td>
<td>5120</td>
<td>4790</td>
<td>4940</td>
</tr>
<tr>
<td></td>
<td>V90%**</td>
<td>5210</td>
<td>4840</td>
<td>5010</td>
</tr>
<tr>
<td>PTV IMC</td>
<td>V95%*</td>
<td>3650</td>
<td>4100</td>
<td>3890</td>
</tr>
<tr>
<td></td>
<td>V90%**</td>
<td>3890</td>
<td>4270</td>
<td>4090</td>
</tr>
<tr>
<td>Heart</td>
<td>Mean Dose</td>
<td>410</td>
<td>300</td>
<td>350</td>
</tr>
<tr>
<td>Contra Lung</td>
<td>V5</td>
<td>8.7%</td>
<td>7.0%</td>
<td>7.8%</td>
</tr>
<tr>
<td>Ipsi Lung</td>
<td>V20</td>
<td>16.5%</td>
<td>16.7%</td>
<td>16.6%</td>
</tr>
<tr>
<td>Contra Breast</td>
<td>Mean Dose</td>
<td>260</td>
<td>230</td>
<td>250</td>
</tr>
</tbody>
</table>

*Dose delivered to 95% of target volume
**Dose delivered to 90% target volume
V5 – Percent of target volume receiving 5Gy or more
V20 – Percent of target volume receiving 20Gy or more
### Results

#### Percent meeting primary dose constraints

<table>
<thead>
<tr>
<th>Target</th>
<th>Primary DC</th>
<th>Mean (range)</th>
<th>% met*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTV Breast Eval</td>
<td>V47.5Gy ≥ 95%</td>
<td>97.1% (89.2-99.5)</td>
<td>92.3%</td>
</tr>
<tr>
<td>PTV Lump</td>
<td>V58.9Gy ≥ 95%</td>
<td>98.5% (94.3-100)</td>
<td>83.3%</td>
</tr>
<tr>
<td>PTV Ax</td>
<td>V47.5Gy ≥ 95%</td>
<td>98.9% (95.9-100)</td>
<td>100%</td>
</tr>
<tr>
<td>PTV SCL</td>
<td>V47.5Gy ≥ 95%</td>
<td>97.3% (92.9-99.6)</td>
<td>76.9%</td>
</tr>
<tr>
<td>PTV IMC</td>
<td>V45Gy ≥ 95%</td>
<td>78.8% (38.1-98.3)</td>
<td>7.7%</td>
</tr>
<tr>
<td>Heart</td>
<td>Mean &lt; 4Gy</td>
<td>L: 4.1Gy (2.4-4.6)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R: 3.0Gy (2.0-4.7)</td>
<td></td>
</tr>
<tr>
<td>Contra Lung</td>
<td>V10% &lt; 5Gy</td>
<td>7.8% (0-20.2)</td>
<td>69.2%</td>
</tr>
<tr>
<td>Ipsi Lung</td>
<td>V20 &lt; 30%</td>
<td>16.6% (10.3-24.6)</td>
<td>100%</td>
</tr>
<tr>
<td>Contra Breast</td>
<td>V5% &lt; 3Gy</td>
<td>2.5Gy (1.1-4.1)</td>
<td>76.9%</td>
</tr>
</tbody>
</table>

DC - dose constraint; % met - percent of plans meeting dose constraint

#### Percent meeting acceptable dose constraint variations

<table>
<thead>
<tr>
<th>Target</th>
<th>Variation DC</th>
<th>Mean (range)</th>
<th>% met*</th>
</tr>
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<tbody>
<tr>
<td>PTV Breast Eval</td>
<td>V45Gy ≥ 90%</td>
<td>98.7% (92.7-100)</td>
<td>100%</td>
</tr>
<tr>
<td>PTV Lump Eval</td>
<td>V55.8Gy ≥ 90%</td>
<td>99.9% (98.7-100)</td>
<td>100%</td>
</tr>
<tr>
<td>PTV Ax</td>
<td>V45Gy ≥ 90%</td>
<td>99.8% (99.2-100)</td>
<td>100%</td>
</tr>
<tr>
<td>PTV SCL</td>
<td>V45Gy ≥ 90%</td>
<td>99.2% (96.6-100)</td>
<td>100%</td>
</tr>
<tr>
<td>PTV IMC</td>
<td>V40Gy ≥ 90%</td>
<td>96.4% (89.6-100)</td>
<td>92.3%</td>
</tr>
<tr>
<td>Heart</td>
<td>Mean &lt; 5Gy</td>
<td>L: 4.1Gy (2.4-4.6)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R: 3.0Gy (2.0-4.7)</td>
<td></td>
</tr>
<tr>
<td>Contra Lung</td>
<td>V15% &lt; 5Gy</td>
<td>7.8% (0-20.2)</td>
<td>92.3%</td>
</tr>
<tr>
<td>Ipsi Lung</td>
<td>V20 &lt; 35%</td>
<td>16.6% (10.3-24.6)</td>
<td>100%</td>
</tr>
<tr>
<td>Contra Breast</td>
<td>V5% &lt; 4.1Gy</td>
<td>2.5Gy (1.1-4.1)</td>
<td>100%</td>
</tr>
</tbody>
</table>

DC - dose constraint; % met - percent of plans meeting dose constraint
Acute Toxicity

Evolution
Background
CT Simulation
Planning
Methods
Results
Conclusion

The James
Conclusion

- Prone breast/RNI is feasible, well-tolerated and results in a less severe acute toxicity profile than what is expected in a population where the average BMI is 38.8 kg/m$^2$ and average breast size is 1888 cc.

Key Components for Successful Prone Treatments

- Integrated team of specialists
- Full patient compliance and understanding
- Proper equipment
- Established Policy & Procedure

Image Source: http://www.engagingothers.com/2012/02/are-you-putting-the-me-in-team/
References


Thank You!

Julia White, MD
Jose Bazan, MD
Sasha Beyer, MD, PhD
Karla Kuhn, CMD
Tina LaPaglia, RT

All of our nurses, radiation therapists and patients at the SSCBC
Questions?

Thank You

To learn more about Ohio State’s cancer program, please visit cancer.osu.edu or follow us in social media:

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Just a reminder that mammogramming your boobs is more important than Instagramming them.

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