Purpose/Objectives

- In whole breast irradiation (WBI), current protocols often specify dosimetric constraints for the contoured breast alone.
- However, adjacent normal tissues outside of the breast may also receive substantial in excess of the prescription within standard tangent fields.
- To better characterize the impact of incidental irradiation of these tissues-in-beam (TIB), we analyzed dosimetric parameters of TIB and associated acute toxicity during hypofractionated whole breast irradiation (HF-WBI).

Materials/Methods

- Tangent field WBI plans for 137 patients treated to 40.5 Gy/15 fractions from 4/2016 to 1/2018 were evaluated.
- Plans were contoured to include the following volumes of interest:

  **Figure 1: Structure description**

  - **Tissues-in-beam (TIB)**: Volume encompassing all breast and non-breast tissues within the 30% isodose line.
  - **Breast**: Breast tissue visible on CT as per RTOG, excluding tissue within 5mm of skin surface.
  - **Non-breast TIB (nTIB)**: Volume remaining after subtracting breast structure from TIB structure.

- Volumes of the TIB, breast, and nTIB receiving 100%-107% of the prescription dose (V100-V107) were calculated in cm³.
- 12 acute toxicities were prospectively collected weekly during WBI including radiation dermatitis, pruritus, fatigue, and hyperpigmentation as per CTCAE v.4; Karfosky Performance Status; pain per intensity scale (0-10); and presence of burning, twinging, tenderness, rash, and dry and most desquamation.
  - Toxicity grade changes of ≥1 unit during WBI were calculated.
  - Relationships between volumetric and dosimetric parameters were assessed using Spearman’s rank-order correlation.
  - Multivariable logistic regressions evaluated TIB V100, V105, and V107 (in cm³) as predictors of acute toxicity outcomes.

Results

**Table 1: Select patient and treatment characteristics by treatment position**

<table>
<thead>
<tr>
<th></th>
<th>Overall, n=137</th>
<th>Prone, n=73</th>
<th>Supine, n=64</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side treated—% right</td>
<td>58%</td>
<td>49%</td>
<td>67%</td>
<td>0.035</td>
</tr>
<tr>
<td>Surgical bed boost—% yes</td>
<td>78%</td>
<td>79%</td>
<td>77%</td>
<td>0.715</td>
</tr>
</tbody>
</table>

**Volumes—mean (SD) in cm³**

- **TIB volume**: 1558.6 (788.9) cm³
- **Breast volume**: 696.8 (453.1) cm³
- **nTIB volume**: 878.8 (455.8) cm³

**Table 2: Significant multivariable logistic regressions for change in toxicity grade as function of TIB V100-V107 (in cm³), controlling for breast V100-V107, treatment position, and boost**

<table>
<thead>
<tr>
<th></th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TIB V100</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burning</td>
<td>1.004</td>
<td>1.001-1.007</td>
<td>0.017</td>
</tr>
<tr>
<td>Twinging</td>
<td>1.004</td>
<td>1.001-1.007</td>
<td>0.015</td>
</tr>
<tr>
<td><strong>TIB V105</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burning</td>
<td>1.025</td>
<td>1.007-1.043</td>
<td>0.006</td>
</tr>
<tr>
<td>Hyperpigmentation</td>
<td>1.017</td>
<td>1.001-1.033</td>
<td>0.039</td>
</tr>
<tr>
<td><strong>TIB V107</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burning</td>
<td>1.098</td>
<td>1.000-1.204</td>
<td>0.049</td>
</tr>
</tbody>
</table>

**Figure 2: Matrix displaying correlations* between TIB, breast, and nTIB volumes in cm³**

*Significant correlations were found between TIB and breast, breast and nTIB, and TIB and nTIB volumes (all p<0.001).

**Figure 3: Plans with V100, V105, and V107 of ≥2 cm³ for TIB, breast, and nTIB volumes**

- V107 is more common in nTIB than in breast structures.
- Increasing breast volume was associated with increasing nTIB V100 (rho= 0.30, p<0.001) but not nTIB V105 or 107.

Conclusions

- For HF-WBI, both breast and non-breast volumes within standard tangent fields commonly received doses in excess of the prescription.
- Such excess doses to TIB were associated with development of acute toxicity outcomes including burning/twinge pain and hyperpigmentation.
- TIB V105 >100 cm³ and V107 >5 cm³ were identified as threshold volumes associated with higher odds of developing acute burning during HF-WBI.
- These data support inclusion of TIB as a region of interest in treatment planning and protocol design. For clinical use of threshold volumes, TIB can be approximated using the exterior structure (orange in Figure 1).