Online Adaptive Replanning for Sequential Boost after Whole Breast Irradiation

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Purpose

Planning CT → Boost plan → WBI 2 Gy x 25 → 1st Fraction CT of Boost

- Variations from WBI to boost
- Dosimetric effects on the IGRT technique
- Advantages of online replanning strategies
Methods

Data Collection
Daily diagnostic-quality CT sets were acquired during IGRT using an in-room CT (CTVision, Siemens) for 19 breast cancer patients.

Processing
Lumpectomy cavity (LC), treated breast, lung and heart, were delineated by populating the contours from the planning CT to each fraction CT using an auto-segmentation tool (ABAS, CMS/Elekta) with manual editing.

Analysis (Part 1: anatomic variations)

\[
\text{relative volume ratio (RVR)} = \frac{\text{LC volume in daily CT}}{\text{LC volume in planning CT}}
\]

\[
\text{maximum overlap ratio (MOR)} = \frac{\text{maximum overlap volume}}{\text{LC volume in planning CT}}
\]
Methods

Analysis (Part 2: dosimetric effects)

Three plans were generated based on the daily CT:

1) Repositioning plan applying the original boost plan with the shift (representing IGRT).

2) Adaptive plan by quickly modifying the original plan using a tool (RealArt, Prowess). The algorithm includes two steps: segment aperture morphing (SAM) and segment weight optimization (SWO).

3) Reoptimization plan by a full-scale optimization.

* The same dose-volume constraints used for the original plan were used for optimization in 2) and 3)
MORs and RVRs

Average RVR: 79.0% ± 18.4%
Average MOR: 68.2% ± 13.4%
MORs and RVRs at the 1st Fractions

15 th

85 th

II

I

III

MOR (%) vs. RVR (%) graph with data points and divisions into sections I, II, and III.
Region II: RVR < 70% (3 cases)
Region II: RVR < 70% (3 cases)

Adaptive plan & Reoptimization plan improve normal tissue sparing for breast (decrease in V50 > 5% for all cases)
Region I: 70% < RVR < 107% (13 cases)
Region III: RVR > 107% (3 cases)

Adaptive plan & Reoptimization plan improve target coverage (increase in V95 > 5% for all cases)
Region I: 70% < RVR < 107% (13 cases)
Region I: 70% < RVR < 107% (13 cases)

All three plans are similar to each other. The advantages of the adaptive and reoptimization plans are not significant (improvement < 5%).
Region I: 70% < RVR < 107% (13 cases)
Region I: 70% < RVR < 107% (13 cases)

<table>
<thead>
<tr>
<th>Structure</th>
<th>Quantity</th>
<th>Repositioning</th>
<th>Adaptive</th>
<th>Reoptimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTV eval V95</td>
<td>92.2</td>
<td>95.2 (3.0)</td>
<td>95.4 (3.2)</td>
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</tr>
<tr>
<td>Breast (ipsi) V50</td>
<td>47</td>
<td>41.9</td>
<td>42.7</td>
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<tr>
<td>Breast (ipsi) V50 - PTV eval</td>
<td>37.4</td>
<td>31.4 (-6.0)</td>
<td>32.3 (-5.1)</td>
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<td>Breast (ipsi) V100</td>
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<td>1.1</td>
<td>1.6</td>
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<tr>
<td>Lung (ipsi) mean</td>
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<td>0.3</td>
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<tr>
<td>Heart mean</td>
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<td>0.3</td>
<td>0.3</td>
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</tr>
</tbody>
</table>

**RVR: 90.5%**  
**MOR: 67.9%**

Adaptive plan and reoptimization plan showed improvement in both target coverage (V95: >3%) and breast tissue sparing (V50: >5%).
Conclusions

1. Variations from WBI to boost
   ✓ Significant variations in LC volume and shape were found from the planning to the 1\textsuperscript{st} fraction of boost.

2. Dosimetric effects on the IGRT technique
   ✓ IGRT can retain the quality of the original plan for the majority of cases (63%), where the variations are small or medium (RVR, MOR >70%, RVR<107%). However …

3. Advantages of online replanning strategies
   ✓ Online adaptive replanning is desirable for patients who experienced
     1) an LC volume decrease > 30% (16% of patients),
     2) an LC volume increase > 7% (16% of patients),
     3) a large LC shape variation (5% of patients).
Thank You!