**ABSTRACT SUBMISSION FORM**

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**PRESENTATION TITLE**

Evaluation of bulk-density pseudo-CT for MR-only treatment planning of MRI-guided accelerated partial breast irradiation

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**ABSTRACT**

Evaluation of bulk-density pseudo-CT for MR-only treatment planning of MRI-guided accelerated partial breast irradiation

**Purpose**: In radiotherapy (RT) treatment planning electron density (ED) information obtained from planning-CT scans is used for dose calculation. MR images lack ED information and can therefore not be used for dose calculation directly. To enable MR-only treatment planning a pseudo-CT (pCT) can be created from MRI by assignment of ED values. The purpose of this study was to investigate if a bulk density pseudo-CT approach is sufficient for MRI-based treatment planning of MRI-guided accelerated partial breast irradiation (APBI).

**Materials & Methods**: Data consisted of RT planning-CT scans of 10 breast cancer patients that were treated with MRI-guided single dose APBI on a conventional linac (clinical trial NL46017.041.13). Delineations of target volumes and organs at risk (OARs) were available. From a previous MR-linac planning study (1), CT-based intensity-modulated RT treatment plans for single fraction APBI on the MR-linac were available as well. Dose prescription was 20Gy to the PTV_{GTV} and 15Gy to the PTV_{CTV} and all predefined dose constraints (2) were met.

Bulk density pCTs were created by assignment of relative ED values to CT-based contours: 1.0 to the body, and 0.35 to the lungs. In all patients a radiopaque marker (high ED values) was inserted in the tumour, which was not taken into account in pCT generation.

The CT-based MR-linac treatment plans were recalculated on the pCTs. To investigate the dosimetric accuracy we compared the CT and pCT-based dose calculations using dose volume histograms (DVHs) of the PTVs and different OARs: chest wall, skin of the ipsilateral breast, heart, lungs, ipsilateral and contralateral breast. Compared parameters were: D2%, D98%, and Dmean. Additionally, CT and pCT-
Results: Mean DVH differences (relative to 20Gy) for the PTVs and OARs were below 1.5% (Table 1). The absolute average difference in Dmean was around 1.0% (range: -1.3%—-0.1%) for the PTVs and less than 0.3% for the OARs. Absolute average difference in D2% slightly exceeded 1.0% for PTV\textsubscript{GTV} and the ipsilateral breast. Gamma pass rates with 2%/2mm acceptance criteria were 95.2% ±2.3% for PTV\textsubscript{GTV} and 99.1% ±0.5% for PTV\textsubscript{CTV}. Average gamma pass rates for all OARs were >99% (Table 1). Inside the marker region higher gamma values (corresponding to lower agreement between CT and pCT-based dose calculation) were observed. This is probably caused by the large difference in ED value between the radiopaque marker on CT and the pCT-assigned ED value. This contributed to the larger differences in D2% and lower gamma pass rate in the PTV\textsubscript{GTV}. When ignoring the voxels inside the marker the PTV\textsubscript{GTV} gamma pass rate increased to 96.5% ±1.7%.

Conclusions: Dose calculation accuracy for APBI in a 1.5T magnetic field based on bulk density pCT with two tissue classes was comparable to CT-based dose calculation for target volumes and OARs. Further research will focus on the accuracy of bulk density pCTs created from MR images.

**Table 1. Mean DVH differences* (±standard deviations) between CT and pCT-based dose calculations.**

<table>
<thead>
<tr>
<th></th>
<th>Dmean (SD)</th>
<th>D2% (SD)</th>
<th>D98% (SD)</th>
<th>Gamma pass rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTV\textsubscript{GTV}</td>
<td>-0.9% (± 0.4%)</td>
<td>-1.3% (± 0.4%)</td>
<td>-0.4% (± 0.8%)</td>
<td>95.2 ±2.3%</td>
</tr>
<tr>
<td>PTV\textsubscript{CTV}</td>
<td>-1.0% (± 0.3%)</td>
<td>-1.0% (± 0.3%)</td>
<td>-0.7% (± 0.3%)</td>
<td>99.1 ±0.5%</td>
</tr>
<tr>
<td>Skin</td>
<td>0.0% (± 0.1%)</td>
<td>-0.2% (± 0.6%)</td>
<td></td>
<td>100 ±0.0%</td>
</tr>
<tr>
<td>Chest wall</td>
<td>0.0% (± 0.0%)</td>
<td>-0.2% (± 0.4%)</td>
<td></td>
<td>99.9 ±0.1%</td>
</tr>
<tr>
<td>Heart</td>
<td>0.0% (± 0.1%)</td>
<td>-0.3% (± 0.2%)</td>
<td></td>
<td>100 ±0.1%</td>
</tr>
<tr>
<td>Total lung</td>
<td>0.0% (± 0.0%)</td>
<td>0.1% (± 0.4%)</td>
<td></td>
<td>99.1 ±0.7%</td>
</tr>
<tr>
<td>Contralateral breast</td>
<td>-0.1% (± 0.1%)</td>
<td>-0.4% (± 0.3%)</td>
<td></td>
<td>100 ±0.0%</td>
</tr>
<tr>
<td>Ipsilateral breast</td>
<td>-0.3% (± 0.1%)</td>
<td>-1.2% (± 0.4%)</td>
<td></td>
<td>99.9 ±0.0%</td>
</tr>
</tbody>
</table>

*DVH percentage differences are relative to 20Gy