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Adaptive RT for H&N cancer: The usefulness of deformable image registration

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PURPOSE/OBJECTIVES
To carry out geometric and dosimetric evaluation of adaptive H&N IMRT based on a deformable image registration algorithm.

MATERIALS/METHODS
- Planning CT: pCT
- Rescan CT: ReCT
- Cone beam CT: CBCT

pCT was deformed to match the CBCT resulting in deformed structures and deformed CT: dCT

Deformable image registration (Varian SmartAdapt v11)
Dose calculation: AAA (Varian Eclipse)

RESULTS

Geometric results
Relative volume differences between dCT and ReCT, CMS (Center of Mass shifts) and DSC (Dice Similarity Coefficient)

\[ DSC = \frac{2(V_{ReCT} \cap V_{dCT})}{V_{ReCT} + V_{dCT}} \]

<table>
<thead>
<tr>
<th>Structure</th>
<th>Relative volume difference [%]</th>
<th>CMS [cm]</th>
<th>DSC [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTV-T(5)</td>
<td>1.9 (9.5; 62.1)</td>
<td>0.25 (0.11; 0.73)</td>
<td>0.71 (0.59; 0.86)</td>
</tr>
<tr>
<td>CTV-T(5)</td>
<td>1.6 (-6.3; 8.9)</td>
<td>0.36 (0.14; 0.38)</td>
<td>0.86 (0.75; 0.93)</td>
</tr>
<tr>
<td>GTV-N dxt(4)</td>
<td>-15.7 (-66.7; 31.3)</td>
<td>0.19 (0.14; 0.35)</td>
<td>0.72 (0.53; 0.79)</td>
</tr>
<tr>
<td>CTV-N dxt(4)</td>
<td>6.2 (-16.8; 17.1)</td>
<td>0.15 (0.13; 0.20)</td>
<td>0.86 (0.85; 0.91)</td>
</tr>
<tr>
<td>GTV-N sin(4)</td>
<td>4.6 (-17.1; 50.0)</td>
<td>0.28 (0.12; 0.52)</td>
<td>0.64 (0.46; 0.76)</td>
</tr>
<tr>
<td>CTV-N sin(4)</td>
<td>7.6 (-18.5; 137.6)</td>
<td>0.40 (0.08; 0.57)</td>
<td>0.80 (0.55; 0.91)</td>
</tr>
<tr>
<td>Parotid dxt(7)</td>
<td>-12.1 (-28.2; 18.8)</td>
<td>0.30 (0.20; 0.50)</td>
<td>0.78 (0.71; 0.83)</td>
</tr>
<tr>
<td>Parotid sin(7)</td>
<td>-13.8 (-25.1; 18.5)</td>
<td>0.33 (0.18; 0.56)</td>
<td>0.76 (0.69; 0.79)</td>
</tr>
<tr>
<td>Spinal cord(7)</td>
<td>-24.4 (-30.6; 30.4)</td>
<td>0.45 (0.07; 1.0)</td>
<td>0.73 (0.62; 0.78)</td>
</tr>
</tbody>
</table>

Dosimetric results

<table>
<thead>
<tr>
<th>Conformity measure</th>
<th>pCT [%]</th>
<th>dCT [%]</th>
<th>ReCT [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>CI (Conformity Index)</td>
<td>1.3 (1.0; 1.3)</td>
<td>1.3 (1.2; 1.4)</td>
<td>1.5 (1.1; 1.9)</td>
</tr>
<tr>
<td>LCF (Lesion Coverage Fraction)</td>
<td>1.0 (0.95; 1.0)</td>
<td>0.95 (0.94; 0.99)</td>
<td>0.96 (0.94; 1.0)</td>
</tr>
<tr>
<td>NTOF (Normal Tissue Overdosage Fraction)</td>
<td>0.19 (0.04; 0.20)</td>
<td>0.26 (0.14; 0.29)</td>
<td>0.32 (0.13; 0.49)</td>
</tr>
</tbody>
</table>

\[ CI = \frac{V_{95}}{V_{PTV}}, \quad LCF = \frac{V_{PTV_{95}}}{V_{PTV}}, \quad NTOF = \frac{V_{95_{subPTV}}}{V_{95}} \]

\[ V_{95} = \text{Volume covered by the 95\% isodose} \]
\[ V_{PTV} = \text{Volume of the PTV} \]
\[ V_{PTV_{95}} = V_{95} \cap V_{PTV} \]
\[ V_{95_{subPTV}} = V_{95} \setminus V_{PTV} \]

CONCLUSIONS
Deformable image registration may be used as a tool for evaluating the need for replanning. However, deformed structures should, at this point, not replace manually delineated structures.

List of patients indicating at which fraction the CBCT and ReCT were acquired.