Differences were observed between the dose volume metrics calculated on FBCT and other images (PH0%CT, PH50%CT, AVGCT), but no correlation between them

→ Dose calculation based on FBCT is arbitrary. It depends on where the diaphragm is during acquisition of FBCT

The absolute differences between 4D plan dose and dose calculated on AVGCT were small (Table 1)

→ Dose calculation on AVGCT is equivalent to 4D calculation

Table 1 Difference in dose volume metrics between 4D and AVG plans (D in Gy, V in %), suggesting dosimetric calculation on AVGCT is equivalent to 4D calculation.

<table>
<thead>
<tr>
<th></th>
<th>PTV D95%</th>
<th>PTV D90%</th>
<th>PTV D85%</th>
<th>PTV V10 Gy</th>
<th>Cord D95%</th>
<th>Cord D95%</th>
<th>Cord D95%</th>
<th>Cord D95%</th>
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</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.01</td>
<td>0.01</td>
<td>0.16</td>
<td>0.01</td>
<td>-0.01</td>
<td>-0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std Dev</td>
<td>0.01</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
<td>0.03</td>
<td>0.14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When comparing dose calculated on FBCT, PH0%CT, and PH50%CT to AVGCT, the largest percent changes in D98%, D95% and D2% to PTV for IMRT plans were large for VMAT at 6.0%, 5.9% and 5.1%, respectively. Corresponding differences were larger for IMRT compared to VMAT at 4.3%, 4.3% and 2.9%, respectively.

→ Dose predicted on FBCT is not equivalent to 4D calculation

A worst case scenario was presented in Figure 2, where the diaphragm was at deep inspiration during FBCT. V100% in the FBCT plan was overestimated by 3.2% with IMRT and 40.7% with VMAT (Figure 3 and Figure 4)

→ Actual PTV coverage could be dramatically different from planned coverage based on FBCT

For spinal cord, when comparing dose calculated on FBCT to AVGCT, the average changes (± standard deviation) in D10%D3cc and D0.35cc for IMRT plans were 0.08 ±0.18, 0.04 ±0.15 and 0.14 ±0.39 Gy, respectively, and 0.21 ±0.24, 0.29 ±0.38 and 0.29 ±0.34 Gy for VMAT plans

→ In the worst case scenario shown in Figure 2, the changes in D10%D3cc and D0.35cc for IMRT plans were 0.09, 0.09 and 0.17 Gy, respectively, and 0.42 , 0.43 and 0.65 Gy for VMAT plans.

→ Safer to keep spinal cord dose at least 0.5 Gy below the tolerance dose during planning

IMRT technique showed smaller deviation than VMAT in both PTV and OAR dose volume metrics mainly due to posterior and posterior-oblique beam arrangement

SUMMARY / CONCLUSION

Due to interplay between diaphragm motion and dynamic MLC, the use of FBCT for treatment planning in lower thoracic spine SRS could lead to deviations between planned and delivered dose, especially in the context of VMAT delivery

Dose calculation on AVGCT was found to be consistent to that on 4DCT for both IMRT and VMAT delivery

Planning on AVGCT is recommended for cases where diaphragm is in beam’s path

In principle, other motion management methods such as slow CT acquisition and abdominal compression could also reduce the deviation between planned and delivered dose