Intrafraction CBCT Imaging Evaluation During SABR for Lung Tumors and Metastatic Tumors to the Spine

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Abstract

**Purpose:** This study aims to assess the displacement and the time relation from pre-treatment to mid-treatment CBCT acquisition during SABR for lung tumors and metastatic tumors to the spine.

**Materials and Methods:** 258 SABR fractions were analyzed in total, including 774 translational vectors to evaluate intra-fraction displacement: 193 fractions from 50 patients with early stage non-small cell lung tumors and 65 fractions from 15 patients with vertebral metastatic tumors included in this retrospective study. All patients underwent SABR at our center; treatment was delivered with volumetric-modulated arc therapy with a flattened 6-MV photon beam between April 2012 and June 2013. Precise reproducible patient positioning was routinely obtained with the stereotactic double-vacuum whole-body immobilization system. The vertical, longitudinal and lateral vectors were obtained by using local rigid registration of the vertebra located at the level of the region of interest on pre/mid-treatment CBCT scans. Clinical data was obtained to assess the presence of a correlation with the displacement: age, gender, Karnofsky performance status, and pulmonary function test.

**Results:** For lung tumors, 579 translational vectors were obtained from the 193 fractions: mean vertical, longitudinal and lateral motions were -0.2 mm (SD=0.9 mm), -0.5 mm (SD=1.0 mm) and -0.1 mm (SD=0.9 mm). Maximum absolute vertical, longitudinal and lateral motions were 3.0 mm, 4.0 mm and 4.0 mm. The mean translational motion vector was 1.4 mm (SD=0.9 mm). For spine tumors, 195 translational vectors were obtained from the 65 fractions: mean vertical, longitudinal and lateral motions were 0.0 mm (SD=0.8 mm), -0.1 mm (SD=0.6 mm) and 0.1 mm (SD=0.7 mm). Maximum absolute vertical, longitudinal and lateral motions were 2.0 mm, 2.0 mm and 2.0 mm. The mean translational motion vector was 0.9 mm (SD=0.7 mm). Mean time from pre-treatment to mid-treatment CBCT acquisition (Δ CBCT) for the 258 SABR fractions was 23 min (SD=6 min). The translational motion vector did not correlate with the time from pre-treatment to mid-treatment CBCT acquisition in lung and spine tumors, and any of the clinical patient characteristics analyzed.

**Conclusions:** The displacement from pre-treatment to mid-treatment CBCT during SABR for lung and spine tumors is minimal, and does not correlate with the imaging time acquisition.

**Methods and Materials**

**SABR treatment:** between April 2012 and June 2013. Table 1 describes the total vectors analyzed in relation to the fractions and the tumor type. The treatment was delivered with volumetric-modulated arc therapy, flattened 6-MV photon beam. Positioning was done through a double-vacuum whole-body immobilization.

**The vertical, longitudinal and lateral vectors obtained:** local rigid registration of the vertebra located at the level of the region of interest on pre/mid-treatment CBCT scans. The clinical data was obtained and analyzed: age, gender, Karnofsky performance status, and pulmonary function test.

**Figure 1. CBCT scans obtainment of vertical, longitudinal and lateral vectors**

**Figure 2. Proportion of the translational motion vector displacements**

**Figure 3. Translation motion vector and time interval**

<table>
<thead>
<tr>
<th>Translational vectors</th>
<th>Fractions</th>
<th>Mean vertical, longitudinal and lateral motions</th>
<th>Max absolute vertical, longitudinal and lateral motions</th>
<th>Mean translational motion vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung tumors</td>
<td>579</td>
<td>193</td>
<td>-0.2 mm (SD=0.9 mm) -0.5 mm (SD=1.0 mm) -0.1 mm (SD=0.9 mm)</td>
<td>3.0 mm 4.0 mm 4.0 mm</td>
</tr>
<tr>
<td>Spine tumors</td>
<td>195</td>
<td>65</td>
<td>0.0 mm (SD=0.8 mm) -0.1 mm (SD=0.6 mm) 0.1 mm (SD=0.7 mm)</td>
<td>2.0 mm 2.0 mm 2.0 mm</td>
</tr>
</tbody>
</table>

**TABLE 1. Vectors distribution based on fractions and type of tumor**

**TABLE 2. Intrafraction CBCT mean and maximum motions for lung and metastatic tumors to the spine**

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**References**


