Evaluation of doses delivered by SBRT to the lung of an anthropomorphic thorax phantom

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Introduction

The RTOG 0236 protocol evaluates a stereotactic body radiation therapy (SBRT) technique in treatment of patients with medically inoperable stage I/II non-small cell lung cancer. The schema for this treatment is 20 Gy per fraction over 5 fractions for patients with total of 60 Gy. The objective of the study is to determine if radiotherapy involving this type of technique achieves acceptable local control and acceptable treatment-related toxicity in patients with medically inoperable early stage non-small cell lung cancer. Institutions must be credentialed by the RTOG before enrolling patients on this study. This process includes the following steps: complete and submit the Facility Questionnaire to the Image-Guided Therapy QA Center (ITC), obtain IRB approval for this protocol; submit documentation about immobilization, localization and respiratory motion control system to RTOG headquarters; demonstrate the capability to submit plans from the institution’s treatment planning system (TPS) to the ITC; successfully complete a phantom irradiation dosimetry test and perform a “dry run” test.

For the phantom step the RPC designed an anthropomorphic thorax phantom. An evaluation of doses delivered through this technique is presented in this poster.

Methods and materials

The thorax phantom is a water fillable plastic shell that simulates the human thorax. It has structures that represent lungs, the spinal cord and the heart not only in dimension but also in values of tissue density for imaging and treatment purposes (Figure 1).

Fig 1: Thorax phantom plastic shell and internal structures

Fig 2: Thorax phantom and insert
Part of the left lung is a removable insert that includes a centrally-located oval tumor as well as dosimetric systems (Figure 2). The dosimeters are placed to analyze the dose distribution and are:
- 2 TLD inside GTV
- 1 TLD inside heart
- 1 TLD inside spinal cord
- 3 sheets of GafChromic®film in axial, sagittal and coronal planes

Fig 3: CT of thorax phantom
The TLDs located inside the GTV are near the center of the tumor and are used for absolute dose determination.

The institution was instructed to image the phantom and plan a treatment without applying correction for tissue heterogeneity and distribution for the same plan with this correction. The phantom, with the dosimetry system intact, was then returned to the RPC.

The information obtained from the dosimetry system included in the phantom was compared to the isodose distribution reported by the TPS. Profiles on these perpendicular axes were taken from the films and the dose was normalized to the TLD dose.

Table 1: Dose and displacement results

<table>
<thead>
<tr>
<th>Name</th>
<th>TLG / Inst Dose</th>
<th>Displacement (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inst. 1</td>
<td>4.86</td>
<td>0.0</td>
</tr>
<tr>
<td>Inst. 2</td>
<td>4.86</td>
<td>0.0</td>
</tr>
<tr>
<td>Inst. 3</td>
<td>4.86</td>
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</tr>
<tr>
<td>Inst. 4</td>
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<td>Inst. 6</td>
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</tr>
<tr>
<td>Inst. 7</td>
<td>4.86</td>
<td>0.0</td>
</tr>
</tbody>
</table>

The results of the first seven institutions were used to analyze parameters of the irradiation and set criteria for the evaluation of the test.

Discussion

The average ratio of TLG dose and TPS calculated dose to TLG was 0.97 ± 3% for the plan with correction on and was 1.15 ± 3% for the plan with correction off. An analysis of the displacement between dose distributions obtained from the films and from the TPS was done in the region around the target. The maximum displacement found was 5mm. An example of dose profile in one particular combination of planes and direction is shown in Figure 5.

The criteria for the evaluation of this test were set based on these first results. A range of ± 5% around 0.97 was established for dose at the center of the target and a maximum of 5mm was established for the displacement between the TPS dose distribution and film profile near the target. Both criteria are for values based on calculations performed with tissue heterogeneity correction applied. The dose discrepancies found in these preliminary results are consistent with the values obtained by Gary Fisher (AAPM 2004) using the same phantom.

These criteria will be re-evaluated after data from 10 institutions have been analyzed.

References


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