Purpose

Institutions must be credentialed to participate in NCI protocols that allow or require IMRT. The RPC has developed a family of phantoms that are used as a credentialing tool to evaluate the IMRT treatment delivery process of these institutions.

Materials/Methods

The phantom consists of a plastic outer shell and internal structures to represent anatomy. A thorax phantom contains lung-equivalent regions, one of which contains a GTV. A pelvic phantom contains structures representing the prostate, rectum, and bladder. A first IMRT phantom mimics the head and neck region and contains structures representing a planning target volume (PTV) close to an organ at risk (OAR), simulating an oropharyngeal tumor and the spinal cord. The phantom contains a secondary PTV that simulates peripheral nodes. In each phantom, thermoluminescence dosimeters (TLDs) were embedded in each target volume and several of the OARs, and GafChromic® film was inserted in two or three planes through the PTVs.

Institutions were instructed to fill the shell with water on-site, image the phantom, plan a treatment according to RPC guidelines and irradiate the phantom. The institutions were also asked to follow the QA procedures that would be done for a patient. Upon completion the institutions returned the phantom to the RPC. The TLD and film were evaluated by the RPC.

Results

Pelvic Phantom results

13 irradiations were analyzed
11 irradiations met the criteria
2 irradiations failed to meet the criteria
13 institutions are represented
Both of the institutions that failed did not meet the distance to agreement criteria that is applied to the film results.

Head and Neck Phantom results

75 irradiations were analyzed
(20 institutions irradiated multiple times)
34 irradiations failed to meet the criteria
85 institutions are represented
19 failed by TLD results only
5 failed by film results only
10 failed by both film and TLD results

Only 66% of institutions irradiating the head and neck phantom passed the criteria on the first irradiation.

Materials/Methods continued

Peltl Phantom

The pelvic phantom consists of the following:
- Prostate containing 2 TLD
- Bladder
- Rectum
- 2 Femurs each containing 1 TLD
- GafChromic® film in sagittal and coronal planes

The institution is instructed to deliver 18 Gy in 10 fractions to at least 98% of the PTV. A maximum dose of 10.8 Gy may be given to < 2% of the PTV. No part of these normal organs shall receive more than 20 Gy.

Thorax Phantom

The thorax phantom contains the following:
- GTV containing 2 TLD
- Heart containing 1 TLD
- Cord containing 1 TLD
- GafChromic® film in axial, sagittal and coronal planes

The thorax phantom is currently being used to evaluate a stereotactic body irradiation therapy procedure. A study to validate its use for measuring IMRT treatments is underway.

Results continued

Head and neck phantom results continued

The following table summarizes the TLD and film results

<table>
<thead>
<tr>
<th>Institution</th>
<th>Failed Attempts</th>
<th>TLD only</th>
<th>Film only</th>
<th>TLD and Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siemens</td>
<td>34</td>
<td>109</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>TomoTherapy</td>
<td>34</td>
<td>109</td>
<td>19</td>
<td>10</td>
</tr>
</tbody>
</table>

Conclusion

Failures occurred in irradiations delivered by a variety of models of linear accelerator and planned with several treatment planning systems (TPS). Somewhat consistent behavior was seen among the TPSs, although no trends were apparent among the delivery devices. The phantom was valuable for evaluating IMRT treatments at institutions preparing to participate in advanced technology clinical trials.

The phantom is valuable for evaluating IMRT for clinical trials

QA of IMRT is important!

References