Commissioning an Anthropomorphic Spine and Lung Phantom for Remote Dose Verification of Institutions Participating in RTOG 0631
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Introduction
The RTOG developed a new phantom to ensure comparable and consistent radiation administration in spinal radiosurgery clinical trials, particularly the Radiation Therapy Oncology Group protocol 0631. This study assessed the phantom’s dosimetric and anatomic utility. The ‘spine phantom’ is a water filled torso with anatomy encountered in spinal radiosurgery: target volume, vertebral column, spinal canal, esophagus, heart, and lungs. The dose to the target volume was measured with axial and sagittal planes of radiographic film and thermoluminescent dosimeters (TLD). Four irradiations were administered: a four field box plan, a seven field conformal plan, a nine field IMRT plan, and a nine beam IMRT plan. In each plan, at least 69% of the target volume received 8 Gy. For each irradiation the planned and administered dose distributions were registered via pinpricks, and compared using point dose measurements, isodose distributions, and gamma analyses. This gamma analysis test, along with the complement of assessments of the isodose distributions and point dose measurements, were used to determine if the spine phantom is a useful tool for the remote assessment of an institution’s treatment planning and dose delivery regimen.

Materials & Methods
Four different treatment plans were designed in Philips Pinnacle 7.6 and administered to the spine/lung phantom: a four field box, a seven field conformal plan, a seven field IMRT plan, and a nine beam IMRT plan. 8 Gy was prescribed to 95% of the tumor volume in each treatment plan. The following images show the relative dose distributions in each treatment plan; the dark blue contour is the 8 Gy prescription line.

Results
Previous RTOG studies established a 95% pixel passing rate as the baseline for acceptable agreement between planned and measured dose at the 5%/3mm criteria. This study assessed the gamma analysis for one trial in the axial and sagittal planes for each treatment plan. Comparing the gamma analyses are isodose distributions and point dose comparisons. The isodose distributions complement the gamma analysis, allowing for a qualitative assessment of the agreement between the planned and measured dose distributions. For the point dose comparisons, the ratio of the planned dose (from the TPS) to the measured TLD dose was calculated for each TLD location, and the 95% confidence intervals were calculated and plotted at each location. During the administration of the seven field IMRT plan, an error in localization was made; the phantom was shifted approximately 2.5 mm from the correct treatment position. The results from the seven field IMRT irradiations are included for illustrative purposes.

Conclusion
The spine phantom is to be used to test institutions' ability to scan, plan, and administer a stereotactic radiosurgical treatment. The dosimetric utility of the spine phantom was tested using a variety of irradiation plans, from unmodulated beams to clinically applicable IMRT plans. This project assessed the dosimetric agreement between treatment planning and the TLD/radiographic film system implemented in the phantom. This project demonstrated the dosimetric utility of the spine phantom for unmodulated and IMRT treatment plans at radiosurgical dose levels. This project confirmed that the phantom is useful for assessing institutions participating in spinal radiosurgery protocols. The spine phantom provided a useful model for planning intensity modulated radiosurgery for spinal tumors.

References