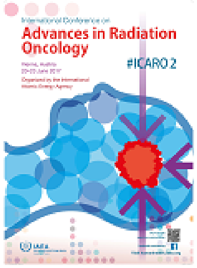

Contribution ID: **315** Type: **Oral Presentation**

Polymer gel dosimetry: a promising 3D quality assurance tool for magnetic resonance-image guided radiotherapy

Thursday, 22 June 2017 10:00 (15 minutes)

INTRODUCTION OF THE STUDY

Safe and accurate delivery of radiation therapy treatment has been the focus of quality assurance (QA) programs. Advances in treatment delivery require development of new quality assurance tools and ongoing evaluation of existing tools.

Magnetic resonance-image guided radiotherapy (MR-IGRT) has been proposed as a new advanced treatment modality in which either a linear accelerator or cobalt sources are combined with a diagnostic MR scanner. Delineation of tumors and adjacent, critical organs is improved by superior soft tissue contrast available on MR images. MR-IGRT devices enable MR image acquisition simultaneously with treatment for an assessment of the tumor volume and its response to treatment in real time.

The presence of a strong magnetic field brings new challenges to the selection of QA detectors as the response of ion chambers and electronic devises can be influenced under such conditions. MR-compatibility is key when choosing detectors.

Polymer gel dosimeters are a useful tool for capturing complex 3D dose distributions with steep dose gradients. The polymerization as a response to radiation dose can be measured with an MR scanner as spin-spin relaxation rates (R2) increase linearly with increasing radiation dose. These properties make them favorable detectors for volumetric QA in MR-IGRT.

METHODOLOGY

Custom-designed glass cylinders of 4 cm height and 5 cm diameter filled with polymer gels were provided by MGS Research Inc (Madison, CT). Two dosimeters were placed separately in a full phantom to assure full scatter conditions and electronic equilibrium. The center of the cylindrical volume was positioned at isocenter distance and a total dose of 5 Gy was delivered with 3x3 cm2 fields at three gantry positions with a non-clinical MR-linac pilot system (MR-Linac, Elekta AB, Stockholm). This MR-IGRT machine combines a 7 MV linear accelerator with a 1.5 T MR scanner.

The first dosimeter was irradiated with the gantry at 0°, 90°, and 180°. For the second dosimeter the gantry was positioned at 0°, 270°, and 180°. Due to an asymmetric phantom design all four cardinal gantry angles weren't feasible.

The entire volume of each dosimeter was imaged with a 3T GE MR scanner 24 hours after irradiation using a 2D spin echo sequence with a repetition time TR = 1000 ms and four echo times TE = 10, 20, 60, and 100 ms. R2 maps were generated for each slice and stacked into a 3D matrix. Field size and penumbra widths were evaluated on the central slices.

The magnetic component of the MR-IGRT treatment delivery unit was turned off for irradiation of these dosimeters. The experiment was repeated in the same order with two more dosimeters with the magnetic field turned on.

RESULTS

The irradiated volume was visible in all dosimeters. In the absence of the magnetic field, the field width measured along the central cross-plane R2 profile across the radiation field was determined to be 28 mm for the first dosimeter and 29 mm for the second. The 80/20 penumbrae widths were 5 mm at both field edges in each dosimeter.

With the magnet ramped up, the field width along the central cross-plane R2 profile measured 29 mm for the third and 28 mm for the fourth dosimeter. The R2 profiles were symmetric as the two opposing beam

deliveries appeared to compensate the effect of the Lorenz forces on the shape of the profile.
The in-plane R2 profiles exhibited an asymmetry as a result of Lorenz forces being exerted on secondary electrons. For the third dosimeter, the deflection of the electrons resulted in a 5 mm wide penumbra where electrons were swept into the radiation field and a 4 mm wide penumbra on the opposite field edge. The difference in penumbra widths wasn't as distinct for the fourth dosimeter; both field edges were 5 mm wide. All measurements fell within the uncertainty of positioning the dosimeters without the lasers that are usually present inside a linear accelerator vault and the uncertainty of selecting the line profiles on the R2 maps (pixel size = 0.8 mm). The irradiated volume of each dosimeter was visualized well with the 3D matrix.

CONCLUSION
Polymer gels show great promise to measure relative, volumetric dose distributions delivered with an MR-IGRT delivery unit in a clinically relevant fashion. We have previously demonstrated that these detectors could capture and resolve steep dose gradients in the presence of a strong magnetic field. The current study encourages further investigation of polymer gels for measuring 3D dose distributions in the presence of magnetic fields.

Country

USA

Institution

University of Houston, UT MD Anderson Cancer Center

Primary author: ROED, Yvonne (UT MD Anderson Cancer Center)

Co-authors: IBBOTT, Geoffrey (UT MD Anderson Cancer Center); PINSKY, Lawrence (University of Houston)

Presenter: ROED, Yvonne (UT MD Anderson Cancer Center)

Session Classification: Session 16b - QA from simulation to delivery

Track Classification: QA/QC