ABSTRACT SUBMISSION FORM

Please email to: info@mriinrt2018.com with 'abstract' as the subject

6th MR in RT Symposium 2018

Name (First, last)	Yvonne Roed
Mailing address (including province/state, country, postal/zip code)	239 Emerson St Apt 15, Houston, TX 77006, USA
Institution/organization	University of Houston, Houston, TX, USA UT MD Anderson Cancer Center, Houston, TX, USA
Position	Postdoctoral Fellow
Telephone (including country prefix)	+1 (832) 531-0452
Email	yvonneroed@gmail.com

The submission is to be considered in the following category	Trainee status
☒ Oral presentation preferred	☒ I am a trainee (student or postdoctoral fellow)
☐ Poster presentation only	☒ I wish to be a candidate for best student paper/poster

PRESENTATION TITLE

The assessment of polymer gel for 3D dosimetry in magnetic resonance-image guided radiotherapy

AUTHOR(S)

Yvonne Roed[1,2*], Lawrence Pinsky[1], Geoffrey Ibbott[2]
[1]University of Houston, Houston, TX, USA
[2]UT MD Anderson Cancer Center, Houston, TX, USA

ABSTRACT

Purpose:
The integration of MR scanners with radiotherapy treatment units provided a new opportunity to demonstrate the value of polymer gels as volumetric dosimeters. The purpose of this work was to investigate the use of methacrylic-acid based polymer gels for quality assurance of patient-specific treatment plans delivered by such novel treatment machines.

Materials & Methods:
Methacrylic-acid based polymer gel dosimeters were provided by MGS Research in customized glass vials (5 cm diameter, 4 cm height). The design enabled the initial characterization of the polymer gels using an electromagnet installed in a linear accelerator vault prior to the installation of the Elekta MR-Linac (MRL), a 7 MV linear accelerator integrated with a 1.5 T MR scanner.
A dose response curve was acquired in the range of 0 Gy to 10 Gy while the dosimeters were in a 1 T magnetic field. The response of the dosimeters was measured with a GE 3 T MR scanner 24 hours post-irradiation. Spin-spin relaxation rates (R2) were determined from MR images.
Following installation of the MRL, dose-rate and fractionation dependence of the gel were evaluated. The effect of the magnetic field on the dose deposition was investigated by irradiating the gels with a small, 3 x 3 cm^2 field at three gantry positions (0°, 90°, and 180°) when the magnet was ramped down and again when it was ramped up. R2 maps were obtained from MR images acquired with the GE 3 T MR scanner a day after exposure and difference maps between with and without magnetic field were determined.

Name (First, last)	Yvonne Roed
Mailing address (including province/state, country, postal/zip code)	239 Emerson St Apt 15, Houston, TX 77006, USA
Institution/organization	University of Houston, Houston, TX, USA UT MD Anderson Cancer Center, Houston, TX, USA
Position	Postdoctoral Fellow

Results:

When irradiated in a magnetic field, R2 values increased linearly with an increase in dose up to 10 Gy. This result was consistent with previously acquired dose response curves without the presence of a strong magnetic field.

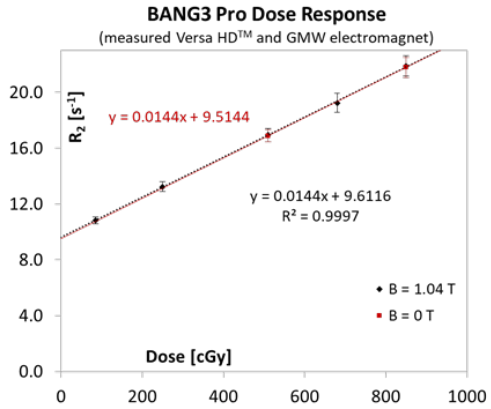

Figure 1: Polymer gel dose response in the presence and absence of a strong magnetic field

An 86 % reduction in dose rate was obtained with the MRL and resulted in a 24 % increase in R2 measurements compared to an exposure of the same dose at 100 % dose rate. Eight percent higher R2 values were obtained when delivering the same dose in multiple fractions compared to a single fraction.

R2 maps generated in the coronal (gantry at 0° and 180°) and the sagittal (gantry at 90°) plane indicated that the irradiated volume was captured inside the dosimeters. R2 difference maps showed the largest differences at the dosimeter edges due to errors in registering two images. Opposing beams appeared to minimize the effect of Lorenz forces on the shape of the profile. An asymmetry in beam profile was observed in the sagittal plane.

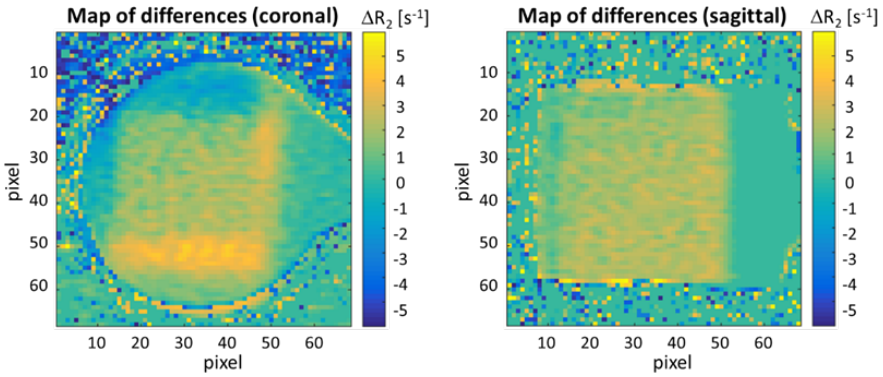

Figure 2: R2 difference maps in coronal (gantry at 0° and 180°) and sagittal (gantry at 90°) plane obtained from MR scans of dosimeters irradiated with small 3 x 3 cm2 radiation fields

Conclusions:

Despite the linear dose response of the gel and its ability to capture complex 3D dose distributions, the strong dose-rate dependence and the non-negligible fractionation dependence rendered the methacrylic-acid based polymer gel unsuitable for clinical dosimetry and quality assurance of patient-specific treatment plans. An adjustment of the current chemical composition might present a decrease in both dose-rate and fractionation dependence so that this polymer gel can be used as a clinical, 3D dosimeter for MR-IGRT machines.