AbstractID: 10163 Title: Comparison of R2 estimation algorithms for polymer gel dosimetry

Purpose: To evaluate R2-estimation algorithms applied for MRI-based polymer gel dosimetry.

Method and Materials: We evaluated weighted least-squared (WLS), least-squared (LS), and maximum-likelihood estimation (MLE) methods. For MLE, we tested both Gaussian and Rician probability distributions (MLE_G and MLE_R). To increase the accuracy of the R2-estimation, we proposed a variable echo number technique (VAREC), in which the number of echo signals used for the estimation was optimized depending on the expected R2-value. The VAREC method was used with WLS and MLE_G. These algorithms were used to estimate R2 values of BANG polymer gel, which was irradiated for 12-different dose levels ranging from 0 to 50 Gy. The R2 measurements were done by using a 32-echo CPMG pulse sequence as implemented in Siemens Trio 3T MRI scanners. Estimated R2 values, <R2>, were plotted as a function of dose for the four methods, which were compared with a reference.

Results: With WLS and MLE_G, <R2> increased up to an absorbed dose of about 6 to 10 Gy; however, above these doses, <R2> decreased with increasing dose. This was a manifestation of an algorithmic error of those methods. When the VAREC technique was used with WLS and MLE_G, the erroneous behavior of the <R2> and dose relationship disappeared. Bothe LS and MLE_R did not show such an error; but, <R2> values for higher doses were overestimated. The computing times of LS and MLE_R were 10 and 60 times longer than MLE_G, respectively.

Conclusion: WLS and MLE_G lead to equally reliable results in a reasonable computing time. Since MLE is known to be more accurate for noisy data than WLS, we strongly recommend the MLE algorithm with the VAREC technique for R2-estimation to the MRI-based polymer gel community.