Analysis of noise in calibration of BANG gel dosimetry using magnetic resonance imaging.

With the development of conformal radiotherapy, particularly intensity modulated radiation therapy (IMRT), there is a clear need for multi-dimensional dosimeters. A commercial polymerizing gel, BANG, has recently been developed that shows great potential as a dosimeter. This study investigated the characterization of the signal-to-noise ratio, and analysis of the artifacts from magnetic resonance (MR) imaging.

Seven cylindrical vials (4 cm diameter, 20 cm length) were irradiated end on. The R_2 values were combined and fit against the corresponding doses in water. A gel calibration sequence was applied which fit a depth-dose curve in water against the change in solvent-proton R_2 relaxivity of the gel. A larger vial (13 cm diameter, 14 cm length) was also irradiated to test the calibration. MR scans (B_0=1.5T, TE = 20ms/100ms, TR=3000ms) were acquired over a series of days to measure the time dependence of the gel response. The calibration proved accurate to within 2.5% in determining the depth dose measured by the larger vial.

Pixel-to-pixel standard deviation ranged from 20 cGy for unirradiated gel to 70 cGy at 2000 cGy. Slice-to-slice deviations were seen that provided 20 cGy systematic variations in dose determinations. These variations limited the overall accuracy of the gel depth-dose determination and warrant an investigation of more accurate MR readout sequences. Noise-power spectrum analysis showed the noise was due to the readout sequence rather than intrinsic gel response fluctuations.