

Purpose: preliminary investigation of the new unique formulation of BANG3-Pro polymer gels for detecting and mapping local variations of LET in proton beam deliveries.

Methods: Four polymer gel dosimeters – labeled A through D and employing four different systems of free-radical chain-termination and chain-transfer– were irradiated by a 230 MeV proton beam in a spread-out Bragg peak modulation (SOBP, 10 cm water-equivalent range, 6 cm width). The dosimeters were read out using an optical laser CT scanner OCTOPUS-IQ, yielding three-dimensional optical density distributions. All polymer gels and the laser CT scanner were developed and made by MGS Research, Inc. To illustrate the LET-dependent response variations, the residual signal was isolated by subtracting the PDD curve obtained by ion chamber measurements from the measured depth profiles of optical density, normalized to the proximal end of the SOBP. The residual signal was then spatially correlated to the analytically calculated depth profile of LET.

Results: Three of the four dosimeters showed an over-response (as compared with IC measurements) at the distal end of the SOBP consistent with their formulation. The peak magnitude of over-response was 0%, 2%, 12%, and 17% for gels A, B, C, and D, respectively. Spatial correlation with calculated LET depth profiles revealed that gels A and B had no measurable dependence on LET and that gel C responded nearly linearly in the limited range from 1.5 to 2.3 keV/micrometer. The correlation between LET and optical response was most pronounced in gel D, where it was linear up to at least 3 keV/micrometer, with the response threshold at about 1.3 keV/micrometer.

Conclusions: The free-radical chain-transfer and chain-termination system in BANG3-Pro type polymer gel dosimeters can be tailored to map distributions of LET, which may be used to better estimate the relative biological effectiveness of heavy-ion radiotherapy treatments.

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