AbstractID: 13916 Title: Plan-specific proton RBE calculation using Monte Carlo

Purpose: To propose an accurate and applicable RBE calculation for specific patient plans using Monte Carlo simulations.

Methods and Materials: RBE calculation was based on the relationship between RBE and linear energy transfer (LET), which is determined by experiments and the Bethe-Bloch formula. Monte Carlo simulations for proton dose calculation were performed with MCDOSE combined with GEANT3. Scanning proton pencil beams were simulated for this study. An algorithm has been developed to shape the energy spectra and weights to produce the desired SOBPs. Proton therapy (PT) and intensity-modulated proton therapy (IMPT) were planned with those beams.

Results: The 1-beam, 2-beam and 4-beam PT plans and the corresponding IMPT plans were produced for this study. Ten patients were selected to compare the RBEs for different patient geometries. The RBE was calculated specifically for each dose parameter. The results showed that the RBE values ranged from 1.10 to 1.37. The one-beam plan had higher RBE for the rectum and the high dose in the prostate, while the two-lateral beam plan had the lowest RBE for the rectum. The one-beam plan gave the lowest bladder RBE of 1.10. The RBEs corresponding to prostate mean dose and whole body dose were comparable for all plans. The RBEs for those dose points were comparable between PT and IMPT. The RBEs for the volume points (e.g., V65) were also defined for the bladder and rectum and they varied significantly from plan to plan.

Conclusions: The RBE values were not constant and varied from organ to organ and plan to plan. Although the RBEs for the PTV were close to 1.10, they exhibited a big range for critical organs such as the rectum and bladder. Therefore, the RBE values and the RBE-corrected doses should be calculated for each specific proton plan.