Abstract ID: 15258 Title: Optimal frequency of CT imaging for monitoring target volume and estimating delivered dose in standard and hypofractionated prostate proton therapy

Purpose: To evaluate the uncertainty in dose delivery resulted from inter-fractional organ motion in standard and hypofractionated prostate proton therapy, to assess the need for motion reduction to limit dose deviations in hypofractionated delivery, and to estimate optimal CT imaging frequency for target volume monitoring and accurate dose verification.

Methods: We used serial CT images acquired at simulation and daily treatment for ten prostate patients. For each patient, a 3D conformal proton plan (78 Gy, 39 fractions) was created and renormalized for hypofractionated delivery (28, 20, 12 and 5 fractions). The plan was computed on each daily CT. The fractional dose was mapped to the simulation anatomy via deformable registration, with the mapped coverage validated against manual contours. The accurately registered fractions were used to examine whether the target and organ dose accumulated in the various deliveries remained within tolerance, and to evaluate the maximum deviations in dose estimation as a function of imaging frequency.

Results: Three patients had more than 33 accurate fractions, and the other seven had at least ten. Without large rectal gas (causing inaccurate registration and large dose deviations), the accumulated target and organ dose remained within limit for delivery in 39 and 28 fractions. For delivery in 20 and fewer fractions, motion reduction would be needed to maintain target coverage and organ sparing. Ten CT scans were sufficient to detect large, systematic changes of prostate volume. To limit the uncertainty in estimated target coverage (V78Gy) to 3%, and rectal dose (both V75Gy and V70Gy) to 5%, ten scans were also sufficient, unless a significant change of prostate volume was observed.

Conclusions: For delivery in 39, 28 and 20 fractions, the minimum recommended imaging frequency is one for every four, three and two fractions, respectively. Daily imaging is needed for delivery in 12 and 5 fractions.

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