AbstractID: 5812 Title: Predicting dosimetric errors from real-time tumor tracking using a treatment couch during IMRT delivery

Purpose: To determine the dosimetric errors resulting from real-time tumor tracking using a treatment couch-based feedback control system.

Methods: The couch dynamics and controller were modeled as a closed-loop feedback control system. A real-time tumor trajectory was input into the control system and the resulting output residual tumor motion trajectory was determined as a function of varying parameters (time constants and dead times) used to describe the system dynamics. The residual motion trajectory served as the input for a Monte Carlo superposition dose calculation algorithm that sampled the position of the tumor according to the displacement distribution from the residual tumor trajectory. We considered tumor trajectory data from a lung tumor case and applied it to a 7-field IMRT plan in which the prescribed dose was 66 Gy. The motion influenced dose distributions were compared with the "static" and tumor motion without feedback control cases.

Results: The fraction of tumor displacements greater than 3 mm for uncontrolled motion was 0.72, 0.32 for the case in which the couch dynamics were described by two equal time constants of 0.135 s and a dead time of 0.27 s and the controller described by a time constant of 0.20 s. For even smaller time constants and dead times, this fraction reduced to < 0.05. The volume of the GTV receiving the prescription dose was 99% for the static case, 68.9% when uncontrolled tumor motion is present and 98.3% when feedback control is employed and the fraction of tumor displacements > 3 mm is 0.32.

Conclusion: Our results show that real-time tumor tracking may be achieved using a treatment couch with < 2% degradation in tumor volumes receiving the prescribed dose. The motion-influenced dose distributions are more dependent on the distribution of residual tumor displacements than on the maximum instantaneous displacement.