AbstractID: 2563 Title: Motion-compensation in IMRT employing probability distribution of target location: phantom tests and computer simulation

Purpose: To investigate potential utility of the probability density function (PDF) of target location in managing the detrimental effect of target motion on the delivered dose distribution.

Method and Materials: Recent advances in 4-D imaging allowed for a more detailed and precise observation and description of internal organ motion due to respiration. Realistic average target trajectories and corresponding PDF were obtained from the analysis of 4D-CT data. It was assumed that these motion patterns were stable and reproducible during treatment delivery. Dose calculation and treatment plan optimization were performed with a modified "motion kernel", obtained by superimposing pencil beam doses delivered to different instances of anatomy (phases of motion), or, in the first approximation, through convolution of the generic pencil beam kernel with the PDF of target location. With this approach, sample motion-compensated plans were optimized and delivered in fractions to a movable phantom, which reproduced preset motion patterns in two dimensions. Dose measurements were performed with diagnostic film for the linac rates of 100, 300 and 500 MU/minute. Robustness of treatment plans with respect to delivery errors and variations in target motion, as well as interplay with the MLC leaf movement, was further investigated in a computer simulation.

Results: While optimized fluence patterns showed deviation of as much as 50% between standard and motion-compensated plans (for 2-cm peak-to-peak amplitude of target motion), the doses delivered in a single fraction deviated by less than 15% point-by-point, and were within 3% of prescription after 30 fractions (reduced approximately as the inverse square root of the number of fractions).

Conclusion: Phantom tests showed that the use of motion kernel for treatment planning allowed maintaining the conformality of dose distribution delivered over multiple fractions, without expanding planning margins beyond the CTV.

Supported in part by the NCI grant 5P01-CA21239-25, AAPM Summer Undergraduate Fellowship.