AbstractID: 7049 Title: Empirical investigation of 3D intrafraction motion management using a generalized methodology for tracking translating, rotating and deforming targets

Purpose: Real-time tracking of tumor motion is a highly promising approach for intrafraction motion management in thoracic and abdominal cancer radiotherapy. We investigate the geometric and dosimetric impact of a generalized methodology for conformal and IMRT-based radiation delivery to translating, rotating and deforming targets.

Materials and Methods: The methodology is based on the concept of "relocation vectors", which correlate instantaneous target position to each point on the treatment aperture(s), throughout the entire respiratory cycle. These vectors are determined during 4D treatment planning by combining instantaneous target position information, obtained from a real-time position-monitoring (RPM) system, with concurrently acquired 4DCT. The resulting plan comprises multiple "control points". For each point, a set of MLC leaf positions is defined so as to conform to the instantaneous shape of the target and deliver the desired fluence. The methodology is, therefore, independent of the nature of target motion. During dose delivery, real-time RPM data are used to update the relocation vectors so as to dynamically account for changes target shape/position relative to the shape/position observed in the planning stage. Initial studies were performed to demonstrate tracking of linear and elliptical motion. A laboratory system was designed and optical measurements of tracking accuracy and system latency were obtained. The methodology was subsequently tested on a moving lung phantom placed under a clinical linac, and dosimetric measurements were performed using a 2D ion-chamber array.

Results: Tracking accuracy (without using any predictive algorithm) was observed to be ~1.25 mm for motion parallel to MLC leaf travel. For motion perpendicular to leaf travel, accuracy was significantly lower. Dosimetric measurements indicate that tracking achieves efficient dose delivery to the target and, simultaneously, significant dose reduction in surrounding regions.

Conclusions: We have developed a robust, universal tracking methodology to manage 3D intrafraction motion.

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