Purpose: We developed an algorithm to minimize total inter-segment time (TIST) for the MLC-based real-time tumor tracking with step-and-shoot IMRT. This algorithm optimizes a starting phase of tumor motion for each segment to minimize TIST.

Methods: The optimizing algorithm consists of four steps: (1) implementation of feathering motion for the closed leaves that will be opened at the next segment, (2) calculation of inter-segment time for all segments, (3) reordering segments to minimize TIST, and (4) optimization of the starting phase of tumor motion for each segment to minimize TIST. Thirty step-and-shoot IMRT fields from five patients with lung and abdominal cancer were used to test the algorithm. Tumor motion was varied with a period (2.0 to 4.0 s) and a peak-to-peak distance (0.5 to 4.0 cm). TIST and duty cycle for each field were compared to those from the strategy of starting each segment at end-of-exhale.

Results: The TIST was reduced by 54.0% on average (from 30.2 ± 16.9 to 13.9 ± 10.6 s) and, the effective duty cycle was increased from 32 ± 10% to 52 ± 15% for a tumor motion with 4 s and 1.0 cm peak-to-peak. More reduction in the TIST was observed from 45.1 to 72.1% with an increase of the period from 2 to 8 s; effect of reduction was degraded by 54.5 to 46.2% when the peak-to-peak increased from 0.5 to 4.0 cm. The TIST increased when a field size formed by x-jaws increased (correlation coefficient: 0.7).

Conclusions: : Total treatment time was reduced noticeably with the algorithm presented in this study so that real-time tumor tracking can be delivered with step-and-shoot IMRT with an increased duty cycle.

Funding Support, Disclosures, and Conflict of Interest:

This research was supported in part by the Intramural Research Program of the NIH, NCI and in part by a NIH grant 1R01CA133539-01A2.