

AbstractID: 6776 Title: Determination of prospective displacement gate threshold for respiratory-gated radiation delivery from retrospective phase-based gate threshold selected at 4D CT simulation

Purpose: 4D-CT imaging is based on retrospective respiratory phase sorting of an external motion monitor. Subsets of 4D-CT images, encompassing a few respiratory phases are increasingly being used in respiratory-gated radiotherapy to reduce internal tumor displacement. Such subset selection is equivalent to selection of a retrospective phase-based gate threshold on the external motion monitor. Respiratory-gated radiation delivery, however, is based on a prospective respiratory displacement threshold. We aim to establish a relationship between the retrospective phase-based gate threshold selected at simulation and prospective displacement-based gate threshold that should be applied during treatment delivery.

Method and Materials: Over 150 external respiratory motion traces, from 90 patients, with and without audio-visual biofeedback were analyzed. Respiratory gating phase interval was chosen from the 4D-CT-derived tumor motion trajectory. Retrospective displacement gate threshold for the selected phase interval was defined as the average respiratory displacement within the phase interval. By including displacement values that were both within the selected phase interval and retrospective displacement gate threshold, a prospective displacement gate duty cycle was obtained. The external respiratory displacement value that yielded the prospective displacement gate duty cycle was the prospective displacement gate threshold for gated radiation delivery.

Results: Phantom motion tests yielded coincidence of retrospective and prospective gate thresholds within 0.3%. Patient data analysis indicated that the average difference between prospective and retrospective gate thresholds was $8\pm 15\%$ and $4\pm 7\%$ of the total respiratory motion range for smaller and larger phase intervals respectively. With audio-visual biofeedback, corresponding differences were $10\pm 14\%$ and $9\pm 10\%$ respectively.

Conclusion: A relationship between retrospective phase-based gate threshold at simulation and prospective displacement gate threshold at radiation delivery was established and validated for regular and non-regular respiratory motion. Using this relationship, the prospective external displacement gate threshold to be applied at radiation delivery can be reliably estimated from 4D-CT simulation.