AbstractID: 3096 Title: Assessing margins using known tumor motion trajectory and a stochastic convolution/superposition algorithm

Purpose: To incorporate the effect of tumor motion in routine dose calculations for conventional and IMRT treatment planning so that tumor margins can be optimized for individual patients based on their respective motion waveforms.

Method and Materials: We employed the Monte Carlo Superposition method, which uses random sampling of beams, field segments, photon energy and direction, interaction points and kernel rays from appropriate probability distributions. In this work, the isocenter is also randomly sampled from the motion-time waveform of the patient's tumor. To verify the method, we performed film measurements on IMRT phantoms placed on a platform that moves sinusoidally in the left-right or superior-inferior direction with amplitude of 2-cm. For a test clinical case, a hepatic tumor case was created on a humanoid phantom using the Pinnacle^3 IMRT system. The optimized plan was re-calculated using MC-superposition dose engine using a motion waveform representative of typical respiratory induced motion.

Results: Film measurements averaged over 10 fractions agreed with MC superposition with motion calculations (infinite fraction) within 1mm in isodose lines for both static and 2-cm sinusoidal motion cases. In the test IMRT liver case with realistic breathing waveform, the isodose lines are seen to shift in the superior direction. Slight underdosing of the GTV and significant underdosing of the PTV can be seen on the inferior side of the tumor, indicating that the 1cm margin on the GTV was not adequate to cover the tumor on the inferior border. Conversely, the margin was found to be too large on the superior tumor border, suggesting the need to reassign the margins and create a new plan.
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Conclusion: Our method provides a way for the clinicians to make informed decisions about margins required to cover the tumor based on actual motion waveforms of the patient's tumor.