AbstractID: 3418 Title: Incorporating Intra-Fraction Motion Into IMRT Plan Optimization

Purpose:
For treatment planning, clinicians typically compensate for respiratory motion by applying treatment margins that ensure the clinical target volume (CTV) always remains in the treatment field. We have investigated a more sophisticated approach where the pattern of organ motion is directly incorporated into both the dose calculation process and the optimization of IMRT treatment plans, and we have evaluated the degree to which plan quality can be improved by accounting for intra-fraction organ motion during IMRT optimization.

Method and Materials:
In this study, we employed a convolution/superposition based dose calculation that incorporates organ motion. For each photon history, the isocenter is randomly sampled from a probability distribution defined by the respiration-induced anatomical displacement. The resulting blurred pencil beam dose distributions have been incorporated into our IMRT plan optimizations. Comparisons were made between plans optimized using a motion-based dose calculation and those optimized using a static dose calculation. Tests were performed for both a concave target in a phantom and a lung cancer patient.

Results:
For the phantom case, the mean dose to the adjacent organ-at-risk was reduced from 67.3% to 48.4% of the prescribed dose when motion was included in the optimization. For the lung patient, the volume of the right lung receiving greater than 80% of the prescribed dose was reduced from 14.1% to 7.2% when organ motion was included in the optimization.

Conclusion:
The motion-based optimization accounts for the fact that the CTV will not be at all locations with equal probability and is thus more sophisticated than the application of patient specific margins. Consequently, significant additional sparing of critical structures can be achieved by incorporating intra-fraction organ motion into IMRT optimization. Additionally, the agreement between the predicted and delivered doses is improved because the impact of organ motion has been accounted for in the dose calculation.