AbstractID: 8261 Title: A Simplified Method of Dose Accumulation in 4DCT

Purpose: To demonstrate, both in phantom and patient, the feasibility of approximating the subject's density distribution via an average 4DCT image (AVG-CT), calculate cumulative dose delivered during respiration with this technique, and evaluate the results with a full 4D dose summation.

Method and Materials: A series of 4DCT numerical phantoms (9 phases, lung tumor excursions 2, 3, and 4 cm in S-I direction) and their AVG-CT images were generated. For full 4D dose summation, static dose was calculated on each phase, each dose matrix was sampled with known displacement, and dose was accumulated over all phases. Using the same clinical plan, the AVG-CT cumulative dose was calculated by combining the static AVG-CT dose with known tumor displacement, and assuming the dose distribution was the same for all phases. Four lung cancer cases were also evaluated for stereotactic body radiotherapy and conformal treatments. Here, deformable image registration was used to generate the patient-specific motion model from 4DCT. Dose accumulation was analogous to phantom, however, each phase's dose matrix was sampled using the displacement vector field. Dose discrepancy (D) between full 4D summation and AVG-CT approach was calculated and compared.

Results: For all phantoms, AVG-CT approximation yielded slightly higher cumulative doses compared to full 4D summation, with dose discrepancy increasing with increased tumor excursion. *In vivo*, using the AVG-CT coupled with deformable registration yielded a modest increase in cumulative dose relative to full 4D dose summation and not at clinically applicable levels ($D < 2\%$). Even for a patient with substantial tumor motion near the diaphragm, dose discrepancy was within 4%.

Conclusion: Simplifying 4D dose accumulation via the AVG-CT, while fully accounting for tumor deformation due to respiratory motion, has been validated, thereby introducing the potential to streamline the use of 4D dose calculations in clinical practice.

Conflict of Interest: None.