

Purpose: Presently, there is no patient specific dosimetric QA for radiation treatment of moving targets. Here we present a patient specific QA protocol for verification of 4D dosimetry delivered to a moving target in SBRT of lung and liver tumors.

Methods and Materials: The protocol proceeds as follows. The patient's breathing pattern is recorded during 4D simulation and imported to a dynamic phantom incorporating a target that moves within an artificial lung or liver respectively. The patient's treatment plan (e.g. VMAT) is then recalculated on the free-breathing CT of the dynamic phantom. The target is replaced with a 3D dosimeter (Presage), which is then irradiated while moving with the patient's breathing pattern. The dose in Presage is determined by optical-CT, and compared with the planned dose, to generate a 4D dose verification index. An end-to-end test of the protocol was performed on a target undergoing known motion (amplitude 1.5cm, frequency 5s). Under-dose and interplay effects were studied in 3DCRT, IMRT, and VMAT treatment plans, where the static target volume was covered 100% with a prescribed dose of 10Gy.

Results: The whole process from sample preparation to completion of analysis takes about 1.5 hours for a non-interruptive operation in the chain. Measured 3D dose distributions were obtained for moving phantom targets, for all plans, with isotropic resolution of 1mm³. In the control study, where motion was absent, good agreement was observed between planned and measured dose distributions with a 90% 3D gamma pass rate. Clear evidence of interplay and target under-dosing was observed in all motion deliveries under free-breathing. The under-dose at the edge of both ends of the dosimeter along the moving direction was in excess of 30%.

Conclusion: Comprehensive patient specific QA of 4D dosimetry for SBRT of moving lung and liver targets is feasible with the Presage/Optical-CT system.