4D/Gating

A Patient Specific QA Protocol for Verification of 4D Dosimetry
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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

Investigation into the feasibility of using PRESAGE/optical-CT dosimetry for the verification of gating treatments
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This work presents an investigation into the use of PRESAGE dosimeters with an optical-CT scanner as a 3D dosimetry system for quantitative verification of respiratory-gated treatments. The CIRS dynamic thorax phantom was modified to incorporate a moving PRESAGE dosimeter simulating respiration motion in the lungs. A simple AP/PA lung treatment plan was delivered three times to the phantom containing a different but geometrically identical PRESAGE insert each time.Each delivery represented a treatment scenario: static, motion (free-breathing) and gated.The dose distributions, in the three dosimeters, were digitized by the optical-CT scanner. Improved optical-CT readout yielded an increased signal-to-noise ratio by a factor of 3 and decreased reconstruction artifacts compared with prior work. Independent measurements of dose

distributions were obtained in the central plane using EBT film. Dose distributions were normalized to a point corresponding to the 100% isodose region prior to the measurement of dose profiles and gamma maps. These measurements were used to quantify the agreement between measured and ECLIPSE dose distributions. Average gamma pass rates between PRESAGE and EBT were >99% (criteria 3% dose difference and 1.2 mm distance-to-agreement) for all three treatments. Gamma pass rates between PRESAGE and ECLIPSE 3D dose distributions showed excellent agreement for the gated treatment (100% pass rate), but poor for the motion scenario (85% pass rate). This work demonstrates the feasibility of using PRESAGE/optical -CT 3D dosimetry to verify gatin genabled radiation treatments. The capability of the Varian gating system to compensate for motion in this treatment scenario was demonstrated.