AbstractID: 3475 Title: Calculating Biological Effective Dose in the Presence of Organ Deformation

Purpose: Evaluate the total biologically effective dose (BED) delivered to the prostate over the course of treatment in ART, accommodating organ motion using deformable image registration.

Method and Materials: Using an in-treatment-room CT-on-rails, scans are acquired on the first five days of treatment and twice weekly thereafter. For each daily image, large-deformation diffeomorphic registration is performed to determine, for each voxel in the planning image, the location of the corresponding volume of tissue on the patient at the time of a given fractionated treatment. Knowing its position at the time of treatment, it is possible to evaluate the dose acquired by that volume of tissue on the treatment day. These varying doses can be summed for each voxel, yielding a map of the total delivered dose.

However, this total dose does not correctly account for the cumulative radiobiological effect. To incorporate the fractionation biological effect, we use the Linear-Quadratic model. That is, for each voxel in the planning image, we accumulate the dose from each day, taking into account the quadratic dose response incorporating the tissue sensitivity (α/β) for the tissue type of the given voxel. This process yields a distribution of delivered BED.

Results: For a series of patients we evaluate dose distributions and DVHs for planned and delivered BED using published values of α/β. These will be used to compare ART and standard IMRT treatment. Total dose and BED to the prostate are compared to the planned dose and BED, showing appreciable differences.

Conclusion: Voxel-based radiobiological effects instead of voxel-based radiation dose should be accumulated in the fractionated treatment course for patients with organ motion and setup variation.