AbstractID: 10392 Title: Radiobiology-guided IMRT for dose-deficit compensation in permanent interstitial brachytherapy for prostate cancer

Purpose: In permanent interstitial brachytherapy (PIB) for prostate cancer, dose deficits in excess 15% of prescription dose often occur as a result of poor implantation skill, post-implant source migration and procedure-induced prostate edema. Without intervention, these "cold" dose spots could lead to tumor recurrence and treatment failures. IMRT's dose-painting capability is ideal for PIB dose-deficit compensation. However, the temporal and spatial dose-deposition patterns are distinctly different in PIB and IMRT. The aim of this work was to examine the radiobiological impact of using IMRT for PIB dose-deficit compensation. **Method and Materials:** 3D PIB dose/dose-rate distributions of actual patient plans were reconstructed from post-implant CT using Varian BrachyVision3D system. Voxel-specific IMRT compensation plans were generated using Varian Eclipse system. Biologically effective dose (BED) was used to capture the radiobiological interactions of PIB and IMRT dose-delivery with the underlying cellular processes. **Results:** A method for determining voxel-by-voxel radiobiology-based dose-deficit was developed which consisted of 1) calculation of BED_{PIB}-deficit distribution (from the nominal prescribed BED) in the PIB target volume, 2) determine the number (N) of 2-Gy IMRT fractions needed to match the $BED_{IMRT\text{-}2Gy}$ to the 90% of maximum BED_{PIB}-deficit, and 3) determine the required dose-per-fraction (d) at each voxel for the N-fraction IMRT dose-compensation to match $BED_{IMRT\text{-}d}$ to BED_{PIB}-deficit at each voxel. To use the dose-volume based Eclipse system for voxel-specific IMRT plan, the target volume was partitioned into iso-dose-deficit sub-volumes by turning the iso-dose-deficit lines into contours followed by Boolean subtraction of the volumes enclosed by successive iso-dose-deficit contours. This method was successfully demonstrated with actual patient PIB plans, showing the IMRT dose distribution filling the non-uniform cold spots in PIB. **Conclusions:** A radiobiology-guided IMRT technique for PIB dose-deficit compensation has been developed that will enable detailed study of the radiobiological impact of combining treatments of PIB and IMRT.