Purpose: This study compares the differences between planned and estimated delivered doses under an IGART framework for prostate cancer treatment, with an emphasis on margin calculation and the resulting dosimetric consequences.

Methods: Five patients were enrolled in the protocol. PTVs were generated by adding a 1cm isotropic margin to the CTV, except posteriorly where 6mm was employed to limit rectal dose. Two additional IMRT plans were created: one with a 5mm isotropic expansion except 3mm posteriorly, and a 3mm isotropic margin. Daily CBCTs (acquired for each of 42 fractions for a total of 710 CBCT-datasets) were used for the daily localization and dose calculation. B-spline based deformable image registration was performed to register each daily CBCT to reference simulation CT-datasets (SIM-CT). Dose was calculated on each daily CBCT and accumulated using spline-based interpolation on the SIM-CT to estimate overall dose delivered to the patient using all three margin techniques.

Results: For all three margins, the average difference between actual delivered and planned CTV mean doses was within 2%. This discrepancy increased as the margin became smaller. Results were patient-dependent, ranging from 1% to 11% between planned and delivered CTV mean doses. Dose estimations to organs at risk (mean dose to rectum and bladder) increased in the actual delivered doses (up to 40%). For the isotropic 3 mm margin plan, mean doses to the rectum and bladder were reduced 10% to 40% relative to the conventional margin plan.

Conclusions: With IGRT, it is possible to reduce treatment margins in prostate cancer. However, caution should be exercised because IGRT alone cannot fully account for tissue deformation or physiological bladder/rectal filling, which may lead to deficits in PTV coverage. IGART, including an adaptive planning framework, offers the benefit of margin reduction through the evaluation of estimated dose delivery and plan reoptimization.