

AbstractID: 2831 Title: Monte Carlo dose calculation in prostate patients aided by 3D ultrasound imaging

Purpose: To investigate the use of Monte Carlo (MC) dose calculations for improved assessment of the daily treatment dose for prostate patients using novel 3D ultrasound imaging.

Method and Materials: Prostate displacements were measured in 39 prostate cancer patients undergoing external-beam radiotherapy with a 3D ultrasound image guided radiotherapy system (RESTITU, Resonant Medical Inc). The system resides in both the CT-Sim and treatment rooms. It acquires 3D ultrasound (US) data of the pelvic region just prior to the CT-sim, with the 3D US image registered in absolute space. Subsequent 3D US images are also acquired before treatment delivery, resulting in a set of 3D US images of the time-evolving geometry. The system also calculates prostate displacement between the CT-Sim and treatment data sets. An algorithm was developed to combine CT images in a MC dose calculation system with 3D US information such as organ shifts and contours. Dose distributions for both shifted and unshifted CT data were calculated using both a conventional planning system (CADPLAN) and a MC dose calculation system.

Results: MC calculated dose distributions in prostate patients were found to differ significantly from conventional dose calculations using the CADPLAN system, mainly due to the influence of the femoral heads. Incorporation of the 3D US measured prostate shifts in the MC dose calculations clearly show severe tumour underdosage would result if no correction was applied to the patient setup. When correcting the patient setup, calculations taking the time-evolving 3D US contours into account show that significant differences in the dose distributions in the target and surrounding tissue occur compared to a single planning dose calculation.

Conclusion: Ultrasound information from a 3D US system opens up the possibility to obtain improved dose assessments for daily treatment fractions using MC dose calculation techniques, leading eventually to image-guided adaptive radiotherapy.