

AbstractID: 10912 Title: Integrating Real-time Tracking into Image Guided Radiation Therapy for Prostate Cancer Treatment

Purpose: To investigate how a real-time tracking technique, based on implanted transponders, could be effectively integrated into the current process for image-guided radiation treatment of prostate cancer.

Method and Materials:

Current prostate IGRT process includes MR-imaging for prostate delineation, CT simulation for treatment planning, and daily on-board kV- and CBCT-imaging for target alignment. The real-time tracking technique uses implanted radiofrequency transponders and an external detector array (Calypso4D) to monitor prostate motion. This study assess (1) magnetic field induced displacement of transponders during MR imaging, (2) image artifacts introduced by transponders in CT and MR images, (3) image artifacts caused by the transponder detector antenna array in in-room kV and CBCT images. A tissue-equivalent phantom mimicking prostate tissue stiffness was constructed and implanted with 3 operational transponders prior to phantom solidification. CT scans were performed before and immediately after 1.5T and 3.0T MR imaging of the phantom, which used prostate-typical pulse sequences. Transponder positions were independently localized by the Calypso system and by CT/CT image registration and evaluated for MR induced displacement. Image artifacts by modality were assessed in phantom and patient cases.

Results: MR-induced position displacements are minimal (<1.0mm) for both 1.5T and 3T scanners. The temperature variation due to MRI RF heating is <0.1°C. MR image artifacts are most significant with the gradient echo sequence, and have radii ~1.5cm and length~4.0cm. The detector array caused significant deterioration in the CBCT image quality. The visibility of transponders and bony anatomy was not affected on the kV images.

Major changes of the IGRT protocol: (a) MR and CT imaging back-to-back for treatment planning is changed to MR prior- and CT post-implant; (b) Daily CBCT prior- is changed to post-treatment and with detector array removed.

Conclusion: There are tradeoffs in the clinical IGRT flow to accommodate and minimize the substantial imaging artifacts.