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RT-19 - Geometric accuracy of DMLC tracking with an implantable wired electromagnetic transponder. Thomas Ravkilde 1*), Paul J Keall 2,3), Klaus Højbjerre , Walther Fledelius , Esben Worm , Per R Poulsen ., Department of Oncology, Aarhus University Hospital, Aarhus, Denmark, 2) Sydney Medical School, The University of Sydney, Australia and 3) Department of Radiation Oncology, Stanford University, Stanford, CA, USA.

Purpose: Tumor motion during radiotherapy treatment delivery can substantially deteriorate the target dose distribution. A promising method to overcome this problem is dynamic multi-leaf collimator (DMLC) tracking. The purpose of this phantom study was to integrate a wired electromagnetic transponder localization system with DMLC tracking and to investigate the geometric accuracy of the integrated system.

Materials and methods: DMLC tracking experiments were performed on a Trilogy accelerator (Varian Medical Systems, Palo Alto, CA) with a prototype DMLC tracking system. A wired implantable electromagnetic transponder (RayPilot, Micropos Medical AB, Gothenburg, Sweden) was mounted on a motion stage with a 3 mm tungsten sphere used for target visualization in continuous portal images acquired at 7.5 Hz during the experiments. The transponder signal was received by antennae arrays in the table top and used to generate a 3D transponder position signal with 30 Hz frequency that was used for MLC aperture adaption. The tracking system latency was determined as the time lag between the tungsten sphere motion and the MLC aperture motion in the portal images for a sinusoidal motion. The geometric accuracy of the tracking system was measured by programming the phantom to reproduce four representative patient-measured trajectories for prostate and for lung tumors. Prediction was used for the lung tumor trajectories to account for the latency. For each trajectory, three treatments of 72 seconds duration were delivered: (a 358 arc field, (2) a vertical static field, and (3) a horizontal static field. The real-time target localization error of the transponder system was calculated as the difference between the transponder position signal and the programmed motions of the motion stage. The root-mean-square (rms) of the 3D transponder localization error was calculated for each treatment. The beam-target error of the integrated tracking system was determined for each portal image as the 2D positional difference between the tungsten sphere and the MLC aperture center. The rms of the beam-target error was determined for each treatment and compared with the would-be error without tracking.

Results: The tracking system latency was 140 ms. The mean rms of the 3D transponder localization error was 0.5 mm for prostate trajectories and 0.6 mm for lung tumor trajectories. The mean rms of the 2D beam-target error was 0.7 mm (prostate) and 1.0 mm (lung tumors) with tracking and 3.4 mm (prostate) and 4.9 mm (lung tumors) without tracking.

Conclusions: DMLC tracking was integrated with a novel electromagnetic transponder localization system and investigated for arc and static field delivery. The system provides sub-1 mm geometrical errors for most trajectories. The tracking latency is the shortest reported so far for DMLC tracking.

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