

AbstractID: 12828 Title: First clinical development of a failure detection-based online repositioning strategy for prostate IMRT – experiments, simulation, and dosimetry study

Purpose: To implement and evaluate clinic-ready protocols for failure detection-based online patient repositioning using treatment MV beam imaging with minimal usage of on-board kV imaging during prostate IMRT. **Methods and Materials:** We propose a two-step decision-making strategy: (1) to detect marker/target motion potentially beyond a pre-defined threshold through ciné-MV imaging and online-updated characterization of prostate motion and (2) to assess over-threshold displacement and as-needed reposition the patient based on paired MV-kV 3D target localization. Two levels of clinical implementation were evaluated: (1) field-by-field based motion correction for present-day linacs, i.e., with an MV-kV pair and possible repositioning done directly before the next field if an over-threshold event is detected in the current field; (2) instantaneous repositioning, for new-generation linacs with capabilities of simultaneous MV-kV imaging and remote automatic couch control during treatment delivery. Experiments were performed on a Varian Trilogy linac in clinical mode using a 4D motion phantom programmed with typical patient prostate motion trajectories. Dosimetric impact was examined using a 2D ion chamber array. Simulations were done using 536 trajectories from 17 patients. **Results:** Compared to no intervention, despite deterioration of marker detection efficiency caused by MLC blockage, the field-by-field repositioning protocol halved (23% to 10%) the mean percentage of time that target displacement exceeded a 3mm threshold, at minimal cost in additional imaging (one MV-kV pair per 2-3 treatment fractions) and with a very small number of repositionings (once every 4-5 fractions). The instantaneous repositioning approach reduced the over-threshold time tenfold (to <2%), also with low kV usage (2.5/fraction). Information acquired for repositioning using combined MV-kV data was found to have sub-millimeter accuracy. **Conclusions:** This work demonstrated in current clinical setup, significant reduction of any adverse effects of intrafraction prostate motion. The method incurs minimal imaging dose to the patient as compared with other stereoscopic imaging techniques.