AbstractID: 14027 Title: A novel approach to tracking intrafraction prostate motion during volumetric modulated arc therapy with tomosynthesis

Purpose:
To investigate a novel approach that uses independent kV onboard imager and tomosynthesis acquisition to detect intrafraction prostate movement/deformation during volumetric modulated arc therapy (VMAT).
Method and Materials:
Intrafraction motion poses a significant problem in VMAT treatment due to a substantially high dose rate during the treatment. To rapidly detect intrafraction motion, a tomosynthesis acquisition scheme accompanied by an onboard kV imager that can rotate independent of treatment gantry has been simulated and the performance in detecting motion has been investigated. The mutual information (MI) between the reference and the reconstructed tomosynthesis images in a ROI was used to assess intrafraction motion. Twenty two CBCT data acquired before each fraction for one prostate patient have been used to simulate intrafraction motion. The prostate motion was characterized by the displacement of the prostate mid-posterior (MP) points in CBCT data and in the Sim CT. The correlation between the MI and MP displacement was calculated and a paired *t*-test for the MI between group 1 (MP displacement $\leq$ 3 mm) and group 2 (MP displacement > 3 mm) was conducted.
Results:
The MI is sensitive to small shift/deformation and the correlation between the MI and MP displacement is 0.81, which suggests that MI can successfully predict motion. The MI of Group 2 is significantly lower than that of group 1 ($P < 0.05$), which suggests this method can reduce the margin by 3 mm and theoretically increase the dose to the prostate by 10 Gy.
Conclusion:
The proposed technique is a novel extension to the fixed kV system. It can detect intrafraction motion > 3mm and respond to the motion in less than 5s. It has a substantial potential in dealing with intrafraction motion for other sites and adaptive radiation therapy as well.