AbstractID: 10413 Title: A Simplified 4DRT Strategy Using a 3.5D Approach and 3D Planning Tools: A Planning Comparison Study

Abstract:

Purpose: Target motion requires a large treatment margin, causing normal tissue toxicity and limiting dose acceleration to the target in stereotactic body radiotherapy (SBRT). 4DRT with motion tracking promises maximal sparing of normal tissue, but demands ~10-fold increase of planning workload and/or new planning tools, such as deformable image registration, based on 4DCT. We proposed a simplified 4DRT strategy via CT simulation (3.5D) of motion-compensated target for 3D planning.

Methods: Four patients' 4DCT images were used to synthesize the 3.5DCT by aligning the target in all respiratory phases and then averaging these CTs, mimicking a CT acquired using a target motion-compensating platform under the patient on CT couch. A custom-built 3D treatment planning system (3D-TPS) was employed and two new tools were developed for synthesizing the 3.5DCT and an integrated dose-volume histogram (iDVH) based on multi-phase plans. A 3mm margin was applied to the GTV to form the PTV. Dosimetry evaluation of the 4DRT plans was based on the iDVH and 3.5D DVH.

Results: The 3.5DCT-based and 4DCT-based planning produced similar DVH and iDVH to the PTV, while the DVH may slightly over-estimate the dose to normal tissues, since the motion blurring may not fully account for the effect of moving normal tissues into and out of the beam fields. The artificially blurred image may also affect the accuracy of the 3.5D DVH to the normal tissues. However, the 10-fold workload reduction is clinically significant. If any critical structure is in the motion direction and within the motion range (~2 cm), verification should be conducted based on each phase CT.

Conclusion: The 3.5DCT-based 4DRT planning with a motion-free target shows equivalency and simplicity, comparing to 4DCT-based plans. It reduces the 4D planning workload substantially by using the 3.5DCT with 3D-TPS and eliminates the need for deformable image registration.