AbstractID: 10615 Title: On the estimation of error in 4D imaging in regard to radiotherapy tumor motion management

Abstract

Purpose: To quantify the accuracy of 4D-CT as it relates to radiotherapy motion management techniques, specifically determination of tumor motion trajectory (x,y,z)(t), tumor motion envelope, and delineation of the GTV throughout 4D datasets.

Methods: An ideal motion tracking configuration was created with a Standard Imaging Respiratory Gating Platform and four glass marbles of various diameter suspended in polyurethane foam. 4D-CT images were acquired for motion periods and displacements ranging from 3 – 6 s and 1 – 3 cm, respectively. Phase binned 4D images were acquired with a 4-slice GE LightSpeed CT scanner and RPM tracking system. Scans were performed in cine mode with a 2.5 mm slice thickness and a 0.4 s gantry rotation. Cine mode duration for each scanning position was performed for at least one gantry rotation greater than the phantom motion period. Marbles were auto-contoured at -500, 0, 500, 1000, and 1500 HU in all ten phases of the nine total 4DCT image sets. Centroid positions were determined for each auto-contour threshold. Actual motion trajectories were recorded to compare to the observed.

Results: Maximum errors in tumor position throughout a given motion trajectory ranged from 1 – 4 mm. The observed errors showed an inverse relationship with the auto-contour HU threshold used and a direct relationship with the phantom velocity. Motion envelope underestimations ranged from 0 – 7 mm with the highest CT threshold auto-contour resulting in the largest error. Conformality indices were also determined for each contoured marble throughout all 4D image sets.

Conclusion: Considerable errors in the definition of tumor trajectory and the motion envelope were observed in an idealized motion phantom using clinical imaging acquisition parameters and realistic tumor motion settings. Methods defined are useful in quantifying errors associated with 4D imaging modalities as they relate to radiotherapy motion management.

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