AbstractID: 8737 Title: Geometric accuracy of high contrast region visualization on 4D X-ray CT imaging using sinogram binning

Purpose: To assess geometric errors in delineating high-contrast structures from 4DCT-acquired images undergoing simulated motion of various amplitudes. The broader goal is to formulate margin-design guidelines that account for imperfections in 4D target imaging for a range of tumor sizes and motion amplitudes.
Methods and materials: Three spherical objects with different diameters were placed on a moving platform adjusted to provide sinusoidal, one-dimensional motions of various excursions (range: 0.5-4 cm) along the longitudinal axis of a Philips Brilliance scanner. Repeated scans were performed for three pitch values (0.15, 0.11, 0.075). Sinogram data were sorted into 10 different breathing phase bins. In addition, time-averaged and maximum intensity projection (MIP) image sets were reconstructed. Data analysis included qualitative inspection of the shape of scanned objects, comparisons of contoured volumes for the static and moving targets, and centroid motion assessment.
Results: The accuracy of reconstructed objects generally improves with decreasing amplitude and pitch. For large excursions and phases intermediate between exhale and inhale, large deviations from the spherical shape are observed; amplitude and volume deviations are as large as 10 mm and 30%. The observed centroid excursion is always less than the actual bin midpoint excursion. Smaller pitch does not always guarantee better results. The MIP centroid lines up closely with the centroid from time-averaged datasets, but its actual position is underestimated by 3-4 mm as well. There is a tendency for deviations to be larger for datasets reconstructed during inhalation.
Conclusions: The accuracy of 4D-acquired datasets depends on motion characteristics and protocol acquisition parameters. The evaluation of the associated uncertainties is necessary for a more accurate margin design during treatment planning when either one or multiple 4D-derived datasets are used for treatment planning. More studies are required to investigate the clinical significance of such errors.

Supported in part by NIH P01 CA116602