AbstractID: 13558 Title: Quantifying anatomical variability in regressing tumors during active breath hold radiotherapy: A modal dominant deformations approach

Purpose: To quantify and classify interfraction geometric variability of lung tumors for independent analysis.

Method and Materials: 14 research subjects (15 tumors) underwent three weekly repeat breath hold (BH) scans at end of normal inspiration. Images were deformably registered to the planning scan, and the gross tumor volume (GTV), ipsilateral (IL), and contralateral (CL) lungs delineated on the planning scan were propagated to all images. Principal component analysis (PCA) was used to generate two statistical shape models of the structures for each patient: a week to week (W2W) model using only one scan per week and an all scans model using all available images per patient. Principal dominant modes were classified by modal volume and position change and time trend into six discrete classes representing tumor regression (isotropic and anisotropic) or breath hold/lung volume variability. Three novel normalized modal variability indices (mean mode volume, total variances, total dominant variances, concordance variance, and concordance standard deviation) were developed to quantify the BH variability using the W2W and all scans models.

Results: The mean BH variability indices were 1.03%, 13.57%, and 7.3%, representing the percentage of mean shape, total variance, and modes concordances respectively, due to BH reproducibility. 46 dominant modes were identified for all patients in total. 23, 8, 4, 4, 1, and 6 modes belonged to classes 1-6, respectively. Classes 1-2 are rigid shifts associated with BH or error, while classes 3-6 represented deformation due to tumor regression. Modal GTV positional shift was found to correlate with CL volume change in 10/15 subjects.

Conclusion: BH variability indices were used to quantify BH. A novel modal classification system was developed to classify geometric variability by type. Modal GTV positional shift correlation with CL volume is likely due to altered lung function in the IL.

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