AbstractID: 14243 Title: Distribution of lung tissue motion during free breathing

Purpose: To characterize and quantify free breathing lung tissue motion distributions.

Method and Materials: 50 patient data sets were acquired using a 4DCT protocol consisting of 25 ciné scans at abutting couch positions on a 16 slice scanner. The tidal volume of each scan was measured by simultaneously acquiring spirometry and an abdominal pneumatic bellows. Because of the natural variation in breathing patterns, we elected to develop the concept of a representative breath. The representative breath was defined by first dividing the breathing traces into individual breaths, from exhalation to exhalation. A linear breathing drift model was assumed and the drift removed for each breath. Breaths that exceeded one standard deviation in period and amplitude were removed from the analysis. A representative breath was defined as the average time from peak inhalation to a normalized tidal volume. Airflow was determined using a sliding polynomial fit to the representative breath profile. The trajectories were computed using an existing 5D lung tissue trajectory model: $\mathbf{X} = \mathbf{X}_0 + \boldsymbol{\alpha} v + \boldsymbol{\beta} f$ where $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ were previously determined. In order to characterize the motion patterns, the elongation of the trajectories were examined throughout the subject's lungs. Elongation was defined here by generating a bounding box with one side parallel to the $\boldsymbol{\alpha}$ vector and the box lying in the plane defined by the $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ vectors.

Results: The representative breath process provided an excellent method for defining an average breath that had continuous tidal volume and airflow characteristics when the breath was continuously repeated. The elongation varied smoothly throughout the lungs. Left lung elongation was 0.10 ± 0.05 and right lung elongation was 0.09 ± 0.04 in a central coronal lung slice.

Conclusion: As expected, motion elongations were relatively small indicating for many tumor sites, hysteresis motion could be ignored.

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