AbstractID: 11860 Title: Quiet respiration breathing motion model parameters for free-breathing patients

Purpose: To determine the quiet respiration breathing motion model parameters for lung cancer and non-lung cancer patients.

Method and Materials: 49 free-breathing patient 4DCT image data sets (25 scans, ciné mode) were collected with simultaneous quantitative spirometry. A cross-correlation registration technique was employed to track the lung tissue motion between scans. The registration results were fed back to a lung-motion model: $\mathbf{x}= \mathbf{x}_0+\boldsymbol{\alpha} v+\boldsymbol{\beta} f$, where $\mathbf{x}$ is the position of a piece of tissue located at reference position $\mathbf{x}_0$. $\boldsymbol{\alpha}$ is a parameter which characterizes the motion due to local air filling (motion as a function of tidal volume) and $\boldsymbol{\beta}$ is the parameter that accounts for the motion due to the imbalance of dynamical stress distributions during inspiration and exhalation which cause lung motion hysteresis (motion as a function of airflow). The parameters $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ together provide a quantitative characterization of breathing motion that inherently includes the complex hysteresis interplay. The $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ distributions were examined for each patient to determine overall general patterns and intra-patient pattern variations.

Results: For 44 patients, the greatest value of $|\boldsymbol{\alpha}|$ was observed in the inferior and posterior lungs. In three patients, $|\boldsymbol{\alpha}|$ reached its maximum in the anterior lung, while for two patients; $|\boldsymbol{\alpha}|$ was greatest in the lateral lung. The hysteresis motion $\boldsymbol{\beta}$ had greater variability, but for the majority of patients, $|\boldsymbol{\beta}|$ was largest in the lateral lungs.

Conclusion: This is the first report of the 3-dimensional breathing motion model parameter for a large cohort of patients. The overall $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ maps varied smoothly as expected. The majority of patients exhibited consistent $\boldsymbol{\alpha}$ maps, and the $\boldsymbol{\beta}$ maps showed greater intra-patient variability. The motion parameter intra-patient variability will inform our need for custom radiation therapy motion models.

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