AbstractID: 13964 Title: Impact of hysteresis on breathing motion and its distribution

Purpose: To study the impact of hysteresis on breathing motion and its distribution by investigating the angle of hysteresis breathing motion with respect to non-hysteresis breathing motion.

Method and Materials: Hysteresis in breathing motion is defined as the variation between motion trajectories during inhalation and exhalation. A free-breathing lung motion model, $\mathbf{x}= \mathbf{x}_0+\boldsymbol{\alpha}v+\boldsymbol{\beta}f$, where v and f denote tidal volume and air flow respectively, decomposes the breathing motion into a non-hysteresis component $\boldsymbol{\alpha}v$, which is purely due to air filling, and a hysteresis component $\boldsymbol{\beta}f$. The angle between $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ would provide information on the interplay of hysteresis motion and non-hysteresis motion. An angle less than 90º would suggest a positive impact of hysteresis motion on non-hysteresis motion and an angle more than 90º would suggest a negative impact of hysteresis motion on non-hysteresis motion. 49 patient datasets were acquired in Cinè mode. $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ were obtained by linear least-square fitting the registered motions to the tidal volumes and the air flows measured by spirometry.

Result: Hysteresis motion was found to offset non-hysteresis motion at anterior portions of left lungs and posterior portions of right lungs. However, at the posterior portions of left lungs and anterior portions of right lungs, hysteresis motion was found to increase non-hysteresis motion. Hysteresis motion was most likely to take a maximum likelihood angle at 42.1º or 149.5º in the left lungs, and 41.8º or 138.2º in the right lungs with respect to the non-hysteresis motion.

Conclusion: Left lungs and right lungs have distinctly characteristic distributions of the angles between $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$, indicating that different patterns of hysteresis distributions in the left lungs and the right lungs might come from intrinsic properties of both sides of lungs respectively.

This work supported in part by NIHR01CA096679 and NIHR01CA116712