AbstractID: 14245 Title: Quantification of the thorax-to-abdomen breathing ratio for breathing motion modeling

Purpose: To develop a methodology to quantitatively measure the thorax-to-abdomen breathing ratio for breathing motion modeling and breathing motion studies.

Method and Materials: The breathing ratio was quantified by measuring the rate of body volume increase throughout the thorax and abdomen as a function of tidal volume. 15 16-slice 4DCT patient image data sets from the neck through the pelvis were acquired during quiet respiration using a protocol that acquired 25 ciné scans at each couch position. Tidal volume was used as the breathing-cycle surrogate, measured using a spirometer and abdominal pneumatic bellows. The volume within the skin contour at each CT slice was compared against the tidal volume, exhibiting a nearly linear relationship. A linear regression analysis was used to determine $\eta(i)$, defined as the amount of expansion at each slice i per unit tidal volume. The sum $\Sigma\eta(i)$ throughout all slices was predicted to be the ratio of room air density to internal air density; 1.11. The boundary between the thorax and abdomen was determined by examining the patient anatomy and setting the boundary at the Xiphoid process. The thorax and abdomen regions were individually analyzed to determine the thorax-to-abdomen breathing ratios.

Results: The average $\Sigma\eta(i)$ for all data sets was found to be 1.23±0.20, close to the expected value of 1.11. The thorax-to-abdomen breathing ratios were 0.22±0.19. The average $\Sigma\eta(i)$ was 0.20±0.13 in the thorax and 1.04±0.26 in the abdomen. The boundary between the thorax and abdomen was localized using a 50^{th} tidal volume percentile reconstructed CT image.

Conclusion: A method to quantify the relationship between abdomen and thoracic breathing was developed and validated.

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