Total and Regional Lung Volumes Change with Frequency (f) and Tidal Volume (Vt) during High Frequency Oscillatory Ventilation (HFOV)


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Introduction: Two unresolved issues in HFOV are the relationship between mean airway pressure (Paw) and lung volume (Vt) and the effect of f and Vt on intrathoracic distribution of Vt. In 4 supine anesthetized dogs, we performed CT imaging of the entire lung during CPAP and HFOV at Paw of 5 and 12.5 cm H2O (f= 5, 10, 15 Hz, I:E=1:1, Vt=20% ± eucapnic Vt at each f). Images were analyzed by software developed at the Univ. of Iowa. VL was measured as the sum of the air volumes of individual CT slices. The distribution of lung expansion between apex and base was evaluated by assembling sub-volumes of CT slices, delineated by distinctive anatomic markings.

Results: Vt changed with f during HFOV, and was 10% lower than CPAP at 5Hz, increasing toward the CPAP baseline at 10 and 15 Hz. There were further small increases in VL with increasing Vt at each f. The 10% increase in VL from 5 to 15 Hz distributed non-uniformly, with the apex gaining ~5% while the base increased 15% (Figure 1).

Discussion: These results suggest two competing phenomena during HFOV. First, VL changed with f at constant Paw, suggesting an effect of asymmetrical I and E impedances. Second, the differential changes in VL between apex and base with increasing Vt and f, with greater distention at the base, may be due to increasing inertial forces at high instantaneous flow rates.

References: