ATS 2017 Highlights

Respiratory Structure and Function Early Career Professionals

Get to know the newest members of the RSF Assembly

Jacob Herrmann, MS

PhD Candidate

Univ. of Iowa, USA

Contact Jacob

More about Jacob

Is your research clinical, basic science or translational?

Translational Science.

Tell us about your research?

My current focus involves an engineering approach to modeling and experimentally quantifying the distribution of injurious lung stretch during high-frequency and multi-frequency oscillatory ventilation. The long-term goal of this research is to develop patient-specific optimized ventilation strategies, tuning the frequency content of ventilator waveforms to minimize the risk of ventilator-induced lung injury.

Where do you see yourself in 5 years?

Academic research and teaching both provide stimulating challenges and personal fulfillment. I am grateful for the opportunities I've been given, and I aspire to build a career in academia.

What do you find is the main advantage to being an ATS RSF Member?

The RSF community comprises many great minds all specialized in the interplay of respiratory mechanics and physiology from a variety of academic settings, encouraging eclectic perspective and skillsets. Although it may be easy to develop tunnel vision when isolated in our individual struggles, the community breaks us free, validates our efforts, and reinforces our collective vision of the knowledge we seek together.

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If you or someone you know would like to be featured as an ATS RSF ECP please email Jade Jaffar (jade.jaffar@monash.edu)

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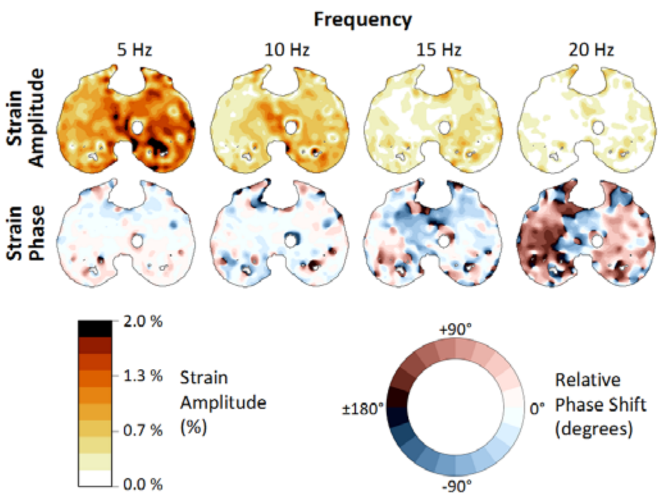

Figure 1. Heterogeneous and frequency-dependent distributions of strain amplitudes and phase shifts in a healthy porcine subject during multi-frequency oscillatory ventilation (MFOV) using 5, 10, 15, and 20 Hz oscillatory flows delivered simultaneously.

Frequency-selective CT imaging captures dynamic lung stretch during oscillatory ventilation

Motivation: We proposed the use of multifrequency oscillatory ventilation (MFOV) as a modification of high-frequency oscillatory ventilation (HFOV) for improving ventilation distribution and minimizing ventilatorinduced lung injury. Direct observation of dynamic regional strain during MFOV is not possible using conventional Xray CT imaging due to motion artifact blurring. We developed frequency-selective computed tomography (CT) for spatial and temporal resolution of periodic lung motion, enabling quantification of regional parenchymal strain during HFOV or MFOV.

Approach: Sedated pigs were scanned during mechanical ventilation (conventional, HFOV, or MFOV) using the frequency-selective CT approach, yielding a sequence of up to 24 volumetric images equally spaced throughout the periodic motion cycle. Tissue-volume-preserving four - dimensional image registration was used to quantify distributions of parenchymal deformation between consecutive timepoints.

Results: Total volumetric strain (peak-to-peak mean $\pm$ standard deviation) during HFOV (7.9% $\pm$ 3.1%) and MFOV (6.9% $\pm$ 2.5%) were substantially lower than during CMV (31.3% $\pm$ 11.6%). The distribution of strain amplitudes during HFOV delivered at 5 Hz tended to vary primarily in the ventral-dorsal direction, in accordance with the gravitational field in supine position. Regional strain amplitudes during MFOV varied with frequency, with different lung regions selectively filtering the harmonic frequency content of the broadband oscillatory flow (Figure 1). Out-of-phase oscillation (pendelluft) occurred primarily at frequencies greater than 10 Hz.

Conclusions: Frequency-selective CT imaging combined with 4-D image registration revealed heterogeneous distributions of parenchymal strain amplitudes and phases during oscillatory ventilation. Frequency-dependent mechanical heterogeneity may result in regional over- and under-ventilation during HFOV, yet may be exploited during MFOV to achieve more even distribution of ventilation.

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