ATS 2025 Highlights

Respiratory Structure and Function Early Career Professionals

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Get to know members of the RSF Assembly

Is your research clinical, basic science or translational?

Clinical and translational.

Tell us about your research?

I am a bioengineer interested in respiratory physiology, and focusing on imaging the functional and structural characteristics of the lungs during spontaneous breathing. My work involves imaging the distribution of gas contrast agents, such as hyperpolarized ^{129}Xe, under normal breathing conditions using a Cine MRI technique. In our lab, we have designed a delivery system for gaseous imaging contrasts and a state-of-the-art MRI sequence to simultaneously measure the dynamics of gas mixing and gas exchange in the lungs. This enables us to study the true physiology and pathophysiology of the respiratory system in real-time during breathing.

Where do you see yourself in 5 years?

In five years, I see myself advancing my research as an Instructor at the University of Pennsylvania, working toward the clinical implementation of an integrated imaging suite.

My goal is to develop a single-session imaging approach that simultaneously produces:

- Lung function maps of ventilation and gas exchange using dynamic xenon MRI
- Breathing mechanics via dynamic proton MRI
- Physiobiological measurements through wash-out techniques

By combining these measurements during spontaneous breathing, my research aims to enhance lung function monitoring and clinical decision-making for interventions.

What do you find is the major benefit of RSF Assembly Membership?

The major benefit of RSF Assembly Membership is the opportunity to be part of a collaborative and interdisciplinary research community focused on advancing scientific and clinical applications in respiratory imaging.

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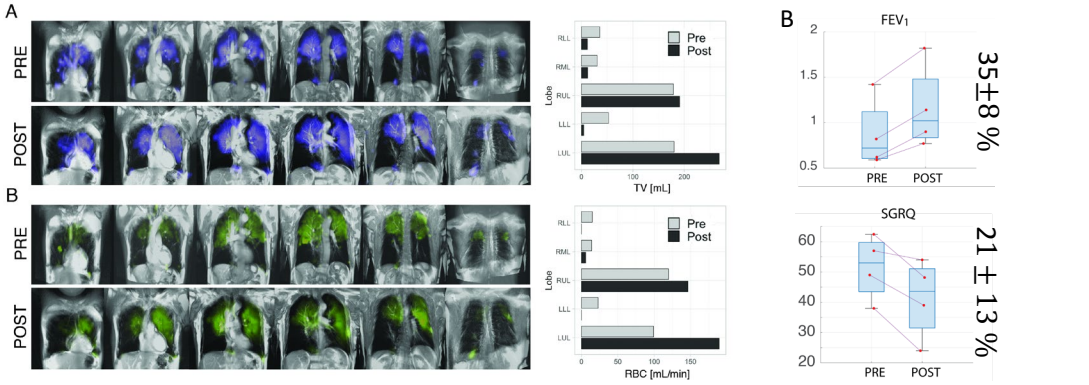

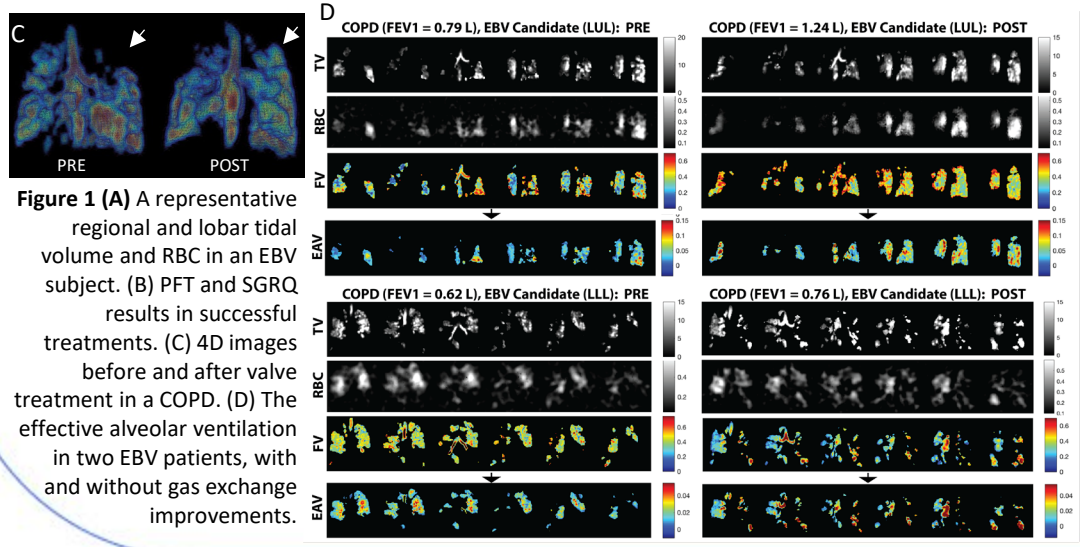

Figure 1 (A) A representative regional and lobar tidal volume and RBC in an EBV subject. (B) PFT and SGRQ results in successful treatments. (C) 4D images before and after valve treatment in a COPD. (D) The effective alveolar ventilation in two EBV patients, with and without gas exchange improvements.

Dynamic Imaging of Physiological Dead Space and Effective Alveolar Ventilation In Patients Undergoing Endobronchial Valve Therapy Using Hyperpolarized Xenon

Objective: Endobronchial valve (EBV) treatment offers a less invasive alternative to lung volume reduction surgery, improving lung function and quality of life, though benefits vary and may decline. While EBV shifts volume, ventilation, and perfusion to healthier lung regions, some patients show objective gains (FEV1, RV) without subjective improvement. This study uses hyperpolarized xenon (HXe) MRI to assess physiological dead space and alveolar volume changes pre- and post-EBV, aiming to clarify this variability, optimize patient selection, and improve decision-making for targeted lobe removal.

Methods: Lung function dynamics were evaluated during normal breathing by delivering ~50mL of HP xenon per inhalation (2.5 L total over five minutes). This enabled realistic visualization of gas flow, diffusion, and exchange. Diaphragm motion was tracked to create a 4D breathing cycle image, with voxel-wise analysis of regional tidal volume (TV), residual volume (RV), fractional ventilation (FV), and maximum-phase maps (TTp). Physiological dead space was quantified by identifying non-gas-exchanging regions via RBC/Gas signal ratios from regional TV maps, while effective alveolar ventilation (EAV) was calculated by normalizing this ratio (RBC/Gas) and adjusting for gas mixing efficiency, FV, providing a comprehensive global measure of lung function. We hypothesize that successful treatment reduces physiological dead space and increases effective alveolar ventilation (EAV) in subjects who subjectively benefit from the treatment.

Results: Subjects (n=22) underwent baseline imaging before treatment, and seven returned for follow-up visits. Figure 1A shows representative EBV patient regional (maps) and lobar (bar charts) TV and gas exchange. PFT and quality-of-life scores indicated variable outcomes, with notable improvements in patients achieving successful atelectasis (Figure 1B). Figure 1C shows one slice of 4D images of gas distribution at end-inhale post-treatment. Figure 1D presents effective alveolar ventilation (EAV) before and after valve placement for two successful treatments—the left case showing improvements in gas exchange (from 852 to 1664 mL), while the right case demonstrated improvements in FEV_1 and ventilation but not in gas exchange (from 857 to 881 mL) in a subject who did not report any subjective improvement.

Conclusion: We identified alveolar ventilation using HXe MRI, demonstrating clear improvements in lung function and supporting EBV therapy's effectiveness in enhancing regional ventilation and gas exchange.

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