The Use of the ^{129}Xe MRI Ventilatory ADC Approach for the Evaluation of Emphysema Progression

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INTRODUCTION

- ^{129}Xe is a stable, non-radioactive isotope that has the capacity to be imaged with Magnetic Resonance Imaging (MRI).
- Hyperpolarized ^{129}Xe lung MRI, an efficient technique, is utilized in various fields of medical physics and MRI research to assess as well as investigate pulmonary diseases.
- In fact, hyperpolarized gas pulmonary MRI provides the identification of biomarkers of various obstructive lung diseases such as emphysema and bronchopulmonary dysplasia.
- However, emphysema progression is able to cause increasing unventilated lung areas which likely excludes the estimates of the largest apparent diffusion coefficient (ADC).
- As such, longitudinal observations of the progression of emphysema using hyperpolarized gas MRI-based ADC can be problematic, masking the severity of emphysema.
- A solution to this problem is combining static-ventilation (SV) and ADC measurements following the idea of ventilatory ADC (vADC).
  - SV measurements providing the gas-distribution should remain to portray an increase in the ventilation defects reflecting the progression of emphysema.

OBJECTIVE & HYPOTHESIS

Objective: To show that emphysema progression can be accurately quantified using the vADC approach by utilizing pulmonary static-ventilation and diffusion-weighted images of ^{129}Xe.

Hypothesis: It is hypothesized that the vADC method adapted for ^{129}Xe MRI should aid to provide an accurate assessment of the emphysema-progression.

METHODS

For this work, we utilized the SV and ADC data acquired using ^{129}Xe MRI in a small group of study subjects to showcase the feasibility of the xenon vADC approach as a possible clinical tool for the longitudinal evaluation and observation of emphysema-progression.

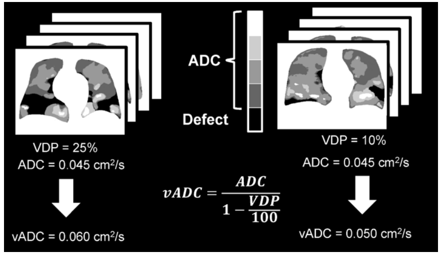

Figure 1. Figure depicting the ventilatory ADC (vADC) approach which requires the combining of ADC measurements and static-ventilation. ADC=apparent diffusion coefficient; VDP=ventilation defect percent.

RESULTS

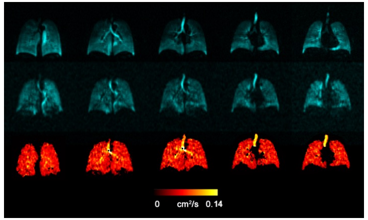

Figure 2. Representative ^{129}Xe MRI static-ventilation images (top-panel), matched voxel-size unweighted (b=0,) images (middle-panel) and correspondent ADC maps (bottom-panel) in coronal view obtained for Patient 2. Images are demonstrating a good match between static-ventilation and key-hole-based unweighted slices.

	Global Mean VDP %	Global Mean ADC (SD), s/cm²	Global Mean vADC, s/cm²
Patient 1	25	0.032 (0.017)	0.047
Patient 2	11	0.040 (0.018)	0.044
Patient 3	3.0	0.036 (0.015)	0.039
Patient 4	10	0.037 (0.016)	0.042
Patient 5	8.0	0.045 (0.018)	0.050

Table 1. ^{129}Xe MRI results for 5 patients.

DISCUSSION AND CONCLUSION

- The results of the study show that the diffusion data reconstructed with the key-hole-technique had sufficient signal to noise ratio to generate reliable ADC maps and reasonable matching (visual image similarity) with the SV data.
- The feasibility of the vADC ^{129}Xe MRI-based approach was demonstrated, so this method can potentially be used to evaluate emphysema progression.
- To prove this concept further, we plan to re-scan the study participants in 12 months to demonstrate the emphysema progression over the year using the vADC approach.

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