Pulmonary Oxygen-Enhanced Ventilation and Arterial Spin Labeling Perfusion Imaging of Asthma

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Introduction MR ventilation-perfusion (V/Q) imaging has been demonstrated using oxygen-enhanced and arterial spin labeling techniques [1-3]. In this study, we apply this V/Q imaging method to asthmatic subjects and compare the findings to those of healthy volunteers.

Materials and Methods All experiments were performed on a GE CV/i 1.5 T Signa system (GE Medical Systems, Milwaukee, WI). Ten healthy volunteers and four subjects with asthma were studied. An arterial spin labeling method called flow-sensitive alternating inversion recovery (FAIR) was used to simultaneously acquired oxygen-enhanced ventilation and FAIR perfusion images in one experimental acquisition [3]. Cardiac-triggered and a single-shot fast spin echo sequence were used. A slice thickness of 15 mm, a field of view of 450 mm, a matrix of 128 x 256, a bandwidth of 250 KHz, an echo spacing of 3.5 ms, and a TI of 1200 ms were used. The subject was asked to perform respiratory pacing to ensure that image acquisition occurred at approximately end-expiration. A series of 25 selective IR images were first acquired, and then a series of 25 nonselective IR images were acquired with the subject inhaling room air. Oxygen flowing at a rate of 15 l/min through a non-rebreathing ventilatory mask was then initiated for the next 25 nonselective IR images. For asthmatic subjects, the whole procedure was repeated at the same slice positions post-albuterol administration. The data were then transferred off-line for image reconstruction. Only images that matched the right lung-liver interface of the reference image were selected and averaged. FAIR perfusion image is obtained by subtracting the average nIR image of room air from that of sIR image, and oxygen-enhanced ventilation image by subtracting the average nIR image of room air from that of 100% oxygen.

Results and Discussion Fig. 1 shows the ventilation and perfusion images of (a) a healthy volunteer and of a subject with severe asthma (b) pre- and (c) post-albuterol inhalation, and (d) the time course of the signal enhancement of normal and asthmatic lung pre- and post-albuterol inhalation. Ventilation and perfusion defects can be observed in the lower left lung (arrows in Fig. 1b) and improved ventilation and perfusion are detected after inhalation of albuterol (arrows in Fig. 1c). Compared to normal lung, negligible signal enhancement is observed in the lower left lung in the time course of the oxygen-enhanced signal intensity pre-inhalation of albuterol, but a delayed enhancement occurs post-inhalation of albuterol (arrows in Fig. 1d). A similar delayed pattern of signal decay is observed after the flow of 100% oxygen ceases (red arrows). While further validation is needed, these preliminary findings indicate that the proposed V/Q imaging method may provide a tool to detect regional assessment of ventilation and perfusion defects in asthma and track its response to pharmacological intervention.

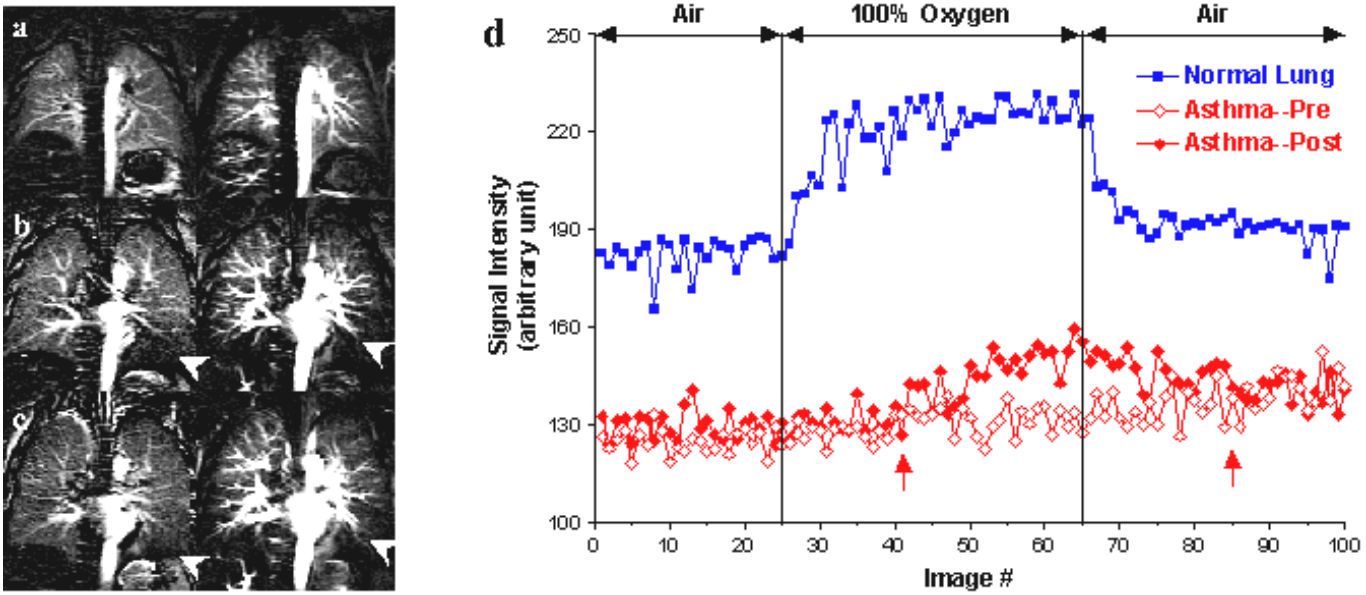

Figure 1. *Pulmonary oxygen-enhanced ventilation and FAIR perfusion images of (a) a healthy volunteer, and a subject with severe asthma (b) pre-albuterol, (c) post-albuterol, and (d) time courses of signal intensities. Note the delayed but slight signal enhancement during the period of inhaling 100% oxygen in the asthma case after the administration of albuterol between the red arrows relative to that before the administration of albuterol. The delayed decay of the post-albuterol signal enhancement after 100% oxygen flow has been stopped can also be observed in asthma case.*

References (1) Edelman RR et al. *Nature Med*. 1996;2:1236-1239. (2) Chen Q. et al. *Radiology* 1999; 213:871-879. (3) Mai VM et al. *MRM* 2002;48:341-350.

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