Pulmonary Oxygen-Enhanced Ventilation and Arterial Spin Labeling Perfusion Imaging with Partial Parallel Imaging (ASSET)

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Introduction MR ventilation-perfusion (V/Q) imaging has been demonstrated using oxygen-enhanced and arterial spin labeling techniques [1,2]. Partial parallel imaging techniques have recently been introduced to achieve improved temporal or spatial resolution, and have been applied to non-contrast, proton MRI of the lung [3-5]. In this study, we apply parallel imaging method (ASSET) to V/Q imaging using oxygen-enhanced and arterial spin labeling techniques.

Materials and Methods All experiments were performed on a GE CV/i 1.5 T Signa system (GE Medical Systems, Milwaukee, WI). Fifteen healthy volunteers (3 females and 12 males) were studied. Contiguous axial slices covering the entire lung were first acquired using a 2D gradient-echo sequence with a TE of 0.6 msec, TR of msec, a flip angle of 5°, and a matrix size of 64 x 64 and were used as references for ASSET image reconstruction. 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 [2]. Cardiac triggering was used where inversion was initiated at a set time delay, approximately 100-500 msec after the detected R wave, and image acquisition was performed after a time delay, TI, of 1200 msec to allow for the inflow of labeled blood. Depending on the heart rate of the subject, the timing was adjusted to allow data acquisition during diastole. A single-shot fast spin echo sequence with 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 was used. The subject was asked to perform respiratory pacing to ensure that image acquisition occurred at end-expiration in which he/she temporarily held breath before the acquisition of each image. Once the gradient knocking sounds finished, the subject would breathe in and out once before temporarily performing breathholding again for the next image acquisition. 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 approximately 1 minute before the acquisition of the next 25 nonselective IR images. Oxygen flow was then turned off for approximately 1 min before acquisition of 25 nIR images during room air was then performed. Oxygen-enhanced ventilation and FAIR perfusion image acquisitions were performed with and without ASSET for comparison. 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 oxygen-enhanced ventilation and FAIR perfusion images of a healthy male volunteer (a) with ASSET and (b) without ASSET. Similar pulmonary anatomical features are observed in both ASSET and non-ASSET images, although there exist minor artifacts resulting from incomplete image reconstruction of ASSET. A slight improvement in spatial resolution of the pulmonary vessels can be observed. Figure 2 shows (a) oxygen-enhanced ventilation and (b) FAIR perfusion from four contiguous coronal slices acquired with ASSET from a female volunteer. These results demonstrate that proton MRI V/Q imaging using oxygen-enhanced ventilation and arterial spin labeling perfusion is feasible in combination with parallel imaging techniques such as ASSET.

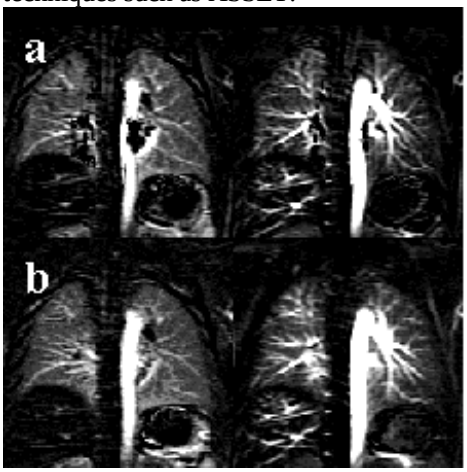

***Fig. 1**. Pulmonary oxygen-enhanced ventilation (left) and FAIR perfusion images (right) acquired with (a) ASSET and (b) without ASSET.*

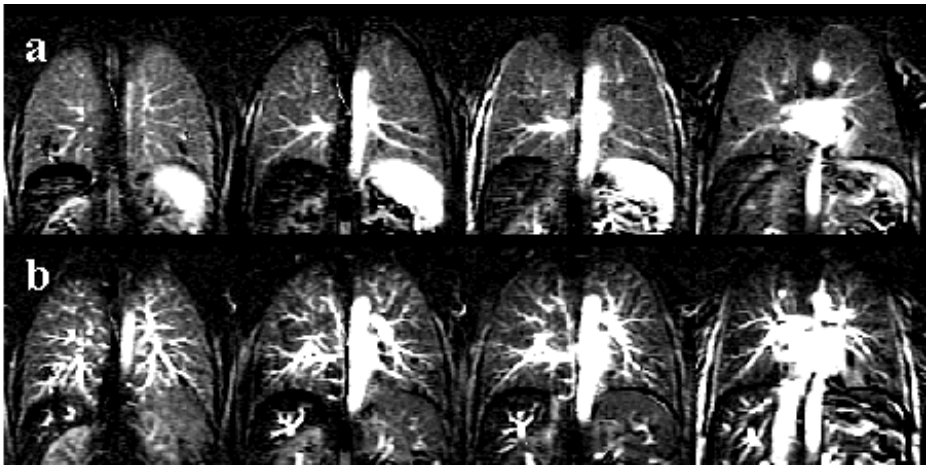

***Fig. 2**. Four contiguous coronal slices of (a) oxygen-enhanced ventilation and (b) FAIR perfusion images acquired with ASSET from a female volunteer. Normal ventilation and perfusion can be observed.*

References (1) Mai VM et al. *JMRI* 2001;14:574-9. (2) Mai VM et al. *MRM* 2002;48:341-50. (3) Sordickson DK *MRM* 1997;38:591-603. (4) Pruessmann KP *MRM* 1999;42:952-62. (5) Heidemann RM *MRM* 2003;49:391-4.

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