Abstract A statistical analysis for ventilation-perfusion imaging is presented using general linear model. Oxygen-enhanced and arterial spin labeling techniques were used for data acquisition. Correlation maps of ventilation and perfusion, obtained in twelve normal volunteers, showed good agreement with difference images. The technique does not require the time-consuming steps of image averaging and subtraction.

Introduction Ventilation-perfusion scanning using oxygen-enhanced and arterial spin labeling techniques has been proposed (1-4). However, it involves image averages and subtraction to generate V/Q images. In this study, we propose the use of functional MRI analysis to generate V/Q images.

Materials and Methods All experiments were performed on a GE CVi 1.5 T Signa system (GE Medical Systems, Milwaukee, WI). Twelve normal volunteers were imaged with a FOV of 400-500 mm and a matrix of 128x256. Simultaneous acquisition of ventilation and perfusion images was performed using flow-sensitive alternating inversion recovery (FAIR) technique, where selective inversion images were referred to as control and nonselective as tag images. The subject alternately inhaled room air and 100% oxygen. A half-Fourier single-shot fast spin echo sequence with an echo spacing of 3.6 ms and an effective echo time of 21 ms was used for image acquisition with the subject alternately inhaling room air and 100% oxygen. The image series were ordered and analyzed using the General Linear Model (GLM), an approach widely used in fMRI analysis. Correlation map of perfusion was generated from the control and tag, while that of ventilation from the tag images acquired during room air and 100% oxygen. Image post-processing were performed on the correlation coefficient maps of ventilation and perfusion, obtained from the difference of the average images. In this study, we propose the use of functional MRI analysis to generate V/Q images.

Results and Discussion The dynamic image series of the average signal intensity of oxygen-enhanced and FAIR studies are shown in Fig. 1. The base line of FAIR signal intensity was measured from the nonselective IR images and the elevated signal intensity was recorded from selective IR images. The base line of the oxygen-enhanced study was measured from nonselective IR images with the subject inhaling room air, while the elevated signal intensity was recorded from the nonselective IR images with the subject inhaling 100% oxygen. The observed patterns for both FAIR and oxygen-enhanced time series present matches to box-car type of references used in fMRI.

Oxygen-enhanced and FAIR images are shown in Fig. 2a, which was obtained from the difference between the average images of 100% oxygen and room air. Correlation maps calculated from the whole series and selected images that share matching right lung-liver interfaces are shown in Fig. 2b and 2c, respectively. Similar features of the lung are exhibited among the correlation maps and the difference images for both oxygen-enhanced ventilation and FAIR perfusion images. Between the correlation maps, the one derived from the selected series of images show consistently greater correlation.

This application of the GLM in processing oxygen-enhanced ventilation and FAIR perfusion data yields qualitative maps, but does not require the tedious steps of image averaging and subtraction, and therefore reduces image processing time. This V/Q technique can be used as a clinical tool to assess pulmonary pathologies such as pulmonary embolism.


This work is supported in parts by grants from the American Heart Association.