In-vivo diffusion weighted ^{19}F MRI using SF_6

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Introduction

DWI of gases has been used extensively for studying chronic obstructive pulmonary diseases. Under similar experimental conditions ADC should permit airway diameters and alveolar sizes to be compared on different subjects [1,2]. Hyperpolarized gases, such as ^{3}He and ^{129}Xe , are usually used for gas MRI. Their main disadvantages arise from polarization, storage and delivery to the subjects. Using thermally polarized gases such as SF_6 comes at the cost of poorer SNR and other timing constraints. SNR can be improved with data accumulations, which increases experiment time, making in-vivo experiments harder to perform. The scope of this study included examining the feasibility of using SF_6 for the in-vivo analysis of ADC, under experimental conditions which could be transferred to clinical environments.

Materials and methods

The Animal Research Committee of each centre involved approved all animal experimentation. Just prior to MRI, the rats were anaesthetized, tracheotomized and supinely located inside a customized multi-nuclear saddle coil [3]. To ensure in-vivo acquisition and to control gas mixing, a home-built computer-controlled MRI-compatible ventilator was used. Images were acquired in a 4.7 Tesla *Bruker Biospec 47/40* spectrometer (Ettlingen, Germany), using a combined spiral-radial sequence (COMSPIRA) [4]. *K*-space was sampled along 64 radial directions, 128 points each. One hundred accumulations were performed on each phase step for the five values of the diffusion gradient so that acquisition and accumulation of each radius for all images could be completed during one 6550 *ms* apnea. Other acquisition parameters were: TR=10*ms*, TE=1.3*ms*, spectral width 101*KHz* , flip angle 60^{o} and no slice selection. Finally, data was regridded onto a Cartesian 128x128 array, Fourier transformed, and displayed as a magnitude image. Diffusion weighting was accomplished through bipolar sinusoidal gradients (1.2*ms* length) in the slice direction. To construct the ADC map, a region of interest (ROI) of the whole image was selected. Image intensity was fitted for each pixel in the ROI, using an exponential decay function with *b* values in the abscissa b = { 402.9; 13320.4; 44418.1; 93696.0; 161154.0 } s/m^2 .

Results and discussion

The first of the five diffusion weighted images after filtering and the ADC map are shown in the figure. Only 57 percent of all points in the ROI had good chi-square values and were included in the map. The apparent diffusion coefficient values range from 1.87×10^{-8} m^2/s to 1.16×10^{-5} m^2/s, with a mean value of 2.22×10^{-6} m^2/s. The spread of the ADC values around the mean fits well with a Gaussian distribution with standard deviation 1.27×10^{-6} m^2/s. To the best of our knowledge, this is the first in-vivo DWI application and the first ADC map obtained using ^{19}F MRI. The time required to collect in-vivo data with good signal to noise ratio should no longer be a limitation for possible clinical applications of ^{19}F MRI.

References

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