# FMRI using ADC-dependent contrast

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## Introduction

Previous study showed that diffusion weighting can be used to eliminate fMRI signal arised from the vasculature (1). It is thus possible to assess the signal that is crushed due to the diffusion weighting. We investigate the changes of apparent perfusion through the changes of apparent diffusion coefficients during brain activation. As suggested by previous investigations on rCBF changes (2,3,4) upon brain activations, local blood flow changes are often much more significant than that of oxygenation. While most spin-tagging based MR methods (3,4) for perfusion imaging for fMRI are sensitive to through-plane flow changes, they often experience difficulties detecting within-plane flow changes. We propose a method here using contrast mechanism that is dependent upon the apparent diffusion coefficient (ADC) changes of the brain vasculature upon brain activation. Sensitive to pseudo-diffusion process of the brain vasculature, this method is potentially a more sensitive method to image human brain function.

## Methods

IVIM model was proposed to study capillary perfusion (5). Capillaries can be considered to have a random walk geometry. With relatively long diffusion time, capillary spins change directions many times, thus can be also treated as a random walk process. Diffusion weighted imaging methods can be used to assess this pseudo-perfusion process. If a Gaussian distribution is assumed for the spin dephasing, the ADC of the capillaries spins is linearly proportional to the flow velocity of the capillary. A study of the ADC time course can then be used to evaluate flow changes in the capillaries during activation. Excessively perfused area due to brain function can thus be identified by examining the ADC time course. An advantage of ADC contrast over conventional perfusion-weighted imaging methods such as EPISTAR and FAIR is its sensitivity to the within-plane flow changes.

A gradient-recalled EPI sequence with isotropic diffusion weighting gradient waveform (6) was used for data collection. A TE of 80 ms and TR of 2 s was used. A range of b factors from 0 to 216 $s/mm^2$ was interleaved in five steps within each data acquisition cluster. Fifty such clusters were obtained during two and half off/on cycles of finger tapping resulting in 250 total images for each experiment. ADC image was obtained through a linear regression on the logrithmic value of the MR signal for each image cluster.

Subjects were instructed to tap their fingers sequentially in a pace of approximately 1 Hz. A slice that contains primary motor cortex was selected for imaging. All experiments were performed on a GE 1.5 T signa scanner (Milwaukee, Wisconsin) equipped with EchoSpeed gradient systems.

## Results

Fig. 1 shows a time course with conventional gradient-recalled EPI. Total number of points were 50. Fig. 2 shows a time course of the apparent diffusion coefficients obtained from the EPI images at the same region of interest. The similarity of the activation pattern demonstrates the feasibility of the proposed approach. Also, the magnitude of the ADC changes is up to 50%, much more significant than the changes based on susceptibility contrast. Because the complex nature of the brain vasculature, ADC of large vessels can not be treated as random walk process. By optimizing the b factor range of the diffusion weighting, one can obtain more specific functional information about vasculature of different size.

## Conclusion and Discussion

This experiment showed preliminary data on using the ADC maps as the basis for detecting fMRI signal. By obtaining more specific knowledge of the ADC ranges of the various proton pools in different brain vasculature, we may be able to assess the contribution from vasculature of different sizes. In conclusion, because of the significant changes of blood flows upon brain activation, this technique is potentially more sensitive to human brain activities than BOLD techniques.

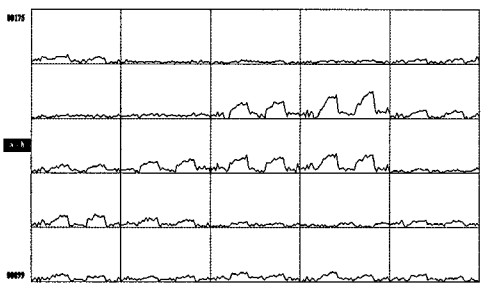

*Figure 1 Time course of GR-EPI images at primary motor cortex.*

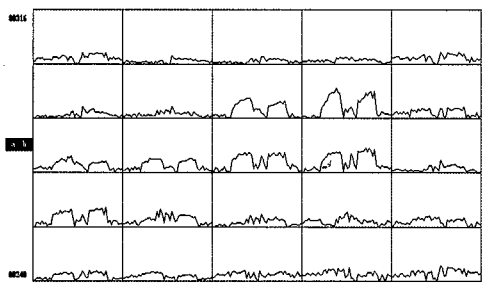

*figure 2 Time course of ADCs at the same region of interest.*

## Reference

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