Functional Magnetic Resonance Imaging Based on Trace Imaging

K. Anami[1], J. Okamoto[2], N. Okamoto[1], H. Matsuda[3], O. Saitoh[1]

[1]Dept. of Psychiatry, National Center Hospital for Mental, Nervous, and Muscular Disorders, NCNP, Kodaira, Tokyo, Japan, [2]Siemens-Asahi Medical Technologies Ltd, Shinagawa-Ku, Tokyo, Japan, [3]Dept. of Radiology, National Center Hospital for Mental, Nervous, and Muscular Disorders, NCNP, Kodaira, Tokyo, Japan

Introduction

Functional imaging based on BOLD contrast is now very widely used because of its non-invasive nature and excellent temporal resolution. On the other hand, one of disadvantages of BOLD contrast imaging is that it does not reflect the direct activity of neural tissue, but does contingent or indirect hemodynamic changes, which brings about slow signal response from the original neural activation. Lately ADC (apparent diffusion coefficient) mapping with a high b value has been proposed as a novel functional MRI method independent from hemodynamics (1). In view of the anisotropic characteristics of neural structure in brain, to detect diffusion change following neural activation, it is favorable for diffusion imaging to be sensitive to diffusion to any directions. Hence, *the trace* - the sum of orthogonal components of the diffusion tensor is the best marker for such an isotropic diffusion state. The trace value keeps constant irrespective of subject's rotating motions, and a trace imaging requires a single scan to obtain the trace value, leading to a short image acquisition time that allows the high-speed functional imaging. Based on these advantages, we employed a trace sequence (2) and attempted to confirmed whether or not the trace imaging could be practically used for functional imaging using a typical visual task

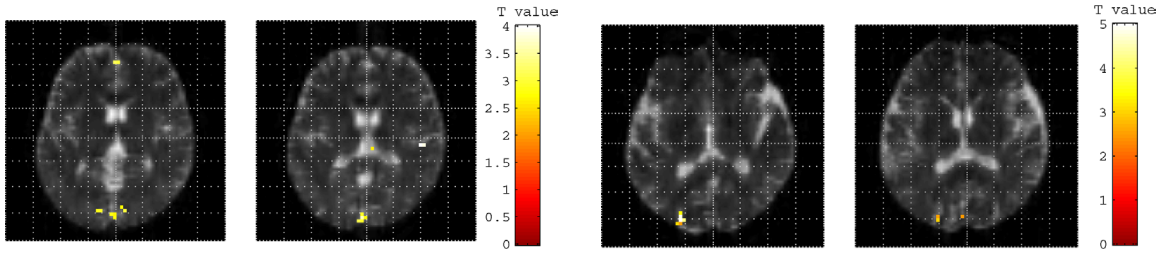
Method

Two healthy subjects (male: 30 y.o, female: 30 y.o.) were recruited for this study. A flickering checkerboard (8 Hz) stimulus was used for a visual task. Siemens Vision Plus scanner (1.5 Tesla) was employed. For functional imaging, we coded a sequence with multiple acquisition capability and with MPG imported from a Siemens sequence (ep2d_d3ta_137b1250_11.ekc) using PARGEN compiler. Total 62 volume acquisitions consisting of adjacent pairs of T2 and trace volume images were performed (TR = 5000 ms, TE = 137 ms, slice number = 21, slice thickness = 5 mm, slice gap = 0.5 mm, b=1000 s/mm^2). Control and task (visual) blocks, each composed of 5 volume scans, were repeated 6 times respectively. The last 60 volume images were analyzed. On Matlab, T2 and trace images were converted to ANALYSE format and the trace value was calculated on individual pixel basis. Then, following the preparatory processing, statistical test with general linear model were performed on SPM99.

Result

ADC change was small but significantly observed ($p<0.005$, uncorrected) in bilateral occipital areas during visual stimulation. (see the figures below)

Result of Subject1 **Result of Subject2**



Discussion

The trace sequence has a problem that it requires a long TE to preserve a high b value such as 1000 s/mm^2, leading to low S/N ratio of MRI images. The sequence we used has TE of 137 ms. It was, however, confirmed that the trace imaging could be used for functional imaging, and was suggested that this method could be practically useful in respect of the sensitivity to diffusion to arbitrary directions, and of shortening the time of image acquisition, thus improving the temporal resolution of the data,

References

(1) Darquie A., et al., Proc Natl Acad Sci U S A. 2001 Jul 31;98(16):9391-5.

(2) Mori S., et al., Magn Reson Med. 1995 Jan;33(1):41-52.