Line Scan Diffusion Tensor Imaging in the brain at 0.2 Tesla MR Imager: Feasibility.

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Introduction

Fractional anisotropy (FA) is a measure of anisotropy [1], by using a diffusion-tensor imaging (DTI) and estimation of water anisotropy in white matter has shown high clinical potential for the diagnosis of white matter disorders. Moreover, white matter water diffusion anisotropy can be used to demonstrate fiber-tracking [2, 3] and to evaluate structural integrity and connectivity in white matter. However, these reports described in the literature were limited on high- field strength MR imager. Among several diffusion-weighted imaging sequences, DWI with line scan data acquisition (LSDWI) does not require high slew rate gradient hardware, and can be implemented on low magnetic field MR imager because LSDWI is the simple spin-echo based one [4]. The purpose of this study was to investigate and measure the values of ADC and FA in the healthy human brain at 0.2 Tesla MR imager and compared them with the values at high field strength reported in the past.

Methods

A total of eight healthy volunteers with no history of neurologic disease participated consecutively in this study. All MR imaging were performed on a 0.2 Tesla MR imager (Signa Profile ver. 7.6, GE-YMS, Tokyo, Japan) equipped with gradients that had a maximum slew rate of 17T/m/sec and a gradient strength of 10mT/m with a standard head coil. To cover the whole brain, LSDWI was performed in 18 transverse sections.

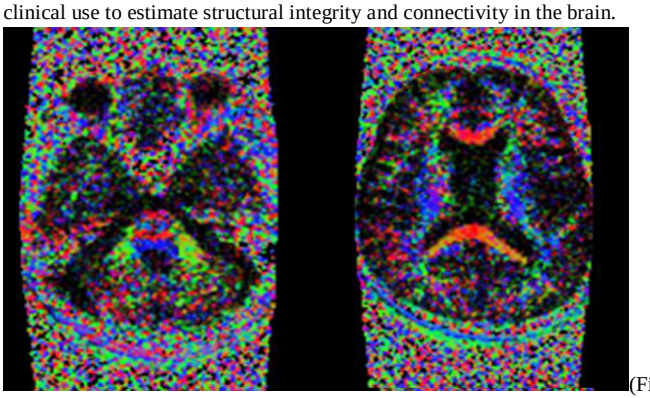
LSDWI was the line scan spin-echo sequence with a pulsed-field-gradient diffusion preparation pulse employing two different b-values (0 and 700 s/mm2) along six directions. Imaging parameters of LSDWI were as follows: TR/ TE =380/ 116 ms, matrix 128x64, bandwidth = 3.92 kHz, FOV = 300x150 mm, slice thickness/gap=6/0 mm and b value of 0 and 700 s/mm^2 with the maximum b value applied in six directions. Subsequently, apparent diffusion coefficients (ADCs) maps and Fractional anisotropy (FA) were calculated from the obtained LSDWI images on a pixel by pixel basis using a software (Functool 2, General Electronic Medical Systems, Milwaukee, WI) and the 3D tract reconstruction and color schemes to represent the orientation of anisotropic tissues are obtained on a PC using a free software (dTV 1.5, developed by Image Computing and Analysis Laboratory, Department of Radiology, The University of Tokyo Hospital, Japan.) For evaluation of ADC and FA, an ROI analysis was performed. ROIs were placed in thalamus, genu of the corpus callosum, centrum semiovales on the images obtained with a *b* value of 0 sec/mm2 and then were projected onto FA and mean diffusivity maps, where ROI mean signal intensities were calculated. Areas with severe geometric distortions were excluded from the analysis. In evaluation of demonstration of corticospinal tracts (Figure 2)on 3D tract reconstraction, good demonstration of the fibers as clear as fibers on images at 1.5 T MR imager was graded as 4, fair as graded 3, poor as graded 2 and none as graded 1.

Results

All LSDWI examinations were successfully imaged. ADC value in the thalamus is 0.78±0.03 (mean ± SD); that in the genu of the corpus callosum, 0.7±0.07; that in the centrum semiovales, 0.75±0.04. FA in the thalamus is 0.38±0.01 (mean ± SD); that in the genu of the corpus callosum, 0.84±0.10; that in the centrum semiovales, 0.49±0.11. These values were comparable with the values at high field strength reported in the past literature [5]. Moreover, fiber-tracking images were able to be obtained using the data on 0.2 Tesla MR imager (Figure 2). The mean grading score of the demonstration of corticospinal tracts was 2.6, which meant that the fibers were demonstrated on images obtained at 0.2 T MR imager but not so clearly as at 1.5T MR imager.

Discussion

The ADCs and FAs measured using the data obtained at 0.2 Tesla MR imager shows the appropriate values. This means that DTI at low field strength is available for clinical use to estimate structural integrity and connectivity in the brain.


(Figure 1)

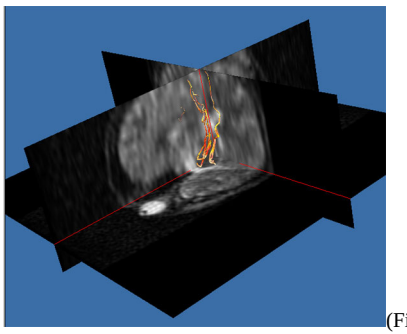

(Figure 2)

Figure1. Color schemes to represent the orientation of anisotropic tissues of a healthy volunteer on 0.2 Tesla MR imager. **Figure2.** A image on the dTV software demonstrates fiber-tracking in pyramidal tract, using LSDWI data on 0.2 Tesla MR imager.

Reference

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