Novel standardization algorithm GAMA for repetitive evaluation of fractional anisotropy in diffusion tensor imaging

A. Matsushita[1], S. Osuka[1], Y. Shibata[1], K. Saotome[2], Y. Nagatomo[3], Y. Komatsu[4], S. Ayuzawa[1], and A. Matsumura[1]

[1]Department of Neurosurgery, University of Tsukuba, Tsukuba, Ibaraki, Japan, [2]Dept. of Radiological Technology, Tsukuba Medical Center Hospital, Tsukuba, Ibaraki, Japan, [3]Dept.of Neurosurgery, Mito Gamma House, Katsuta, Ibaraki, Japan, [4]Dept. of Neurosurgery, Tsukuba Medical Center Hospital, Tsukuba, Ibaraki, Japan

Introduction

Fractional anisotropy (FA) reflects the micro-structures. The decrease of FA is shown in structural abnormalities, for example, damaged brain, multiple sclerosis, Wallerian degeneration and so on. Furthermore, the FA change over time shows informative remarks in some clinical practice. It is important that the region of interest (ROI) has enough repeatability especially for serial measurement. Previous studies proposed the various methods which make the ROI, in order to increase repeatability and objectivity. However, almost methods have troublesome manipulation or low repeatability. As the speed and reliability of the examination are important on clinical case, these methods have limitations. It would be able to get out the limitations to define the same tracts or regions automatically. Therefore, we developed the novel algorithm and software named GAMA. GAMA can point out the regions as corpus callosum or pyramidal tract automatically (Fig.1) and shows the FA values of the regions.

Materials and Methods

Imaging was performed on a Siemense 1.5 Tesla scanner for two healthy men. A single shot echo-planar imaging technique with a bipolar diffusion gradient was utilized with12 non-collinear gradient directions and two b-values (0 and 1000s/mm^2). Five technicians took a diffusion tensor image of each subject from the head fixation to making images independently. The DTI datasets were transferred to a workstation and reconstructed by the software, Volume-One v1.72 and dTV II.SR (Dept. of Radiology, Tokyo University, Japan), then FA map, color-coded map and ADC map were calculated. Five raters assessed the FA three times independently in free-handed ROI and size-fixed sphere ROI located on the corpus callosum and the pyramidal tract in midbrain. Also, we applied the GAMA to the same datasets

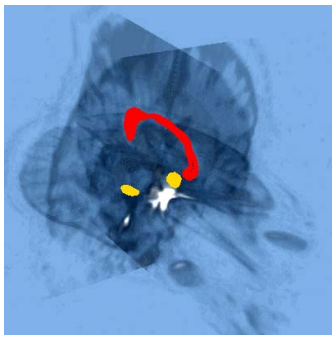

Fig. 1

Results

Figure 2 shows the results of a subject 1's first scan in free-handed ROI and GAMA. The FA had dispersion in every rater's analysis and the mean FA of each rater was different from the other. However, GAMA shows single value of FA and no laterality. In the free-handed ROI method for corpus callosum, the standard deviations (SD) of FA in five scans were 0.05 and 0.06 for two subjects, respectively, and the coefficient of variance (CV) was 9% in both subjects. On the other hand, the SD in GAMA were 0.01 and 0, respectively, and the CV were 2% and 0, respectively. The dispersions in free-handed ROI were larger than in GAMA statistical significantly on both subjects. In the right and left midbrain, the free-handed ROI method showed the largest dispersions with 0.05 to 0.09 in SD and 8 to 16% in CV, and the size-fixed ROI method showed smaller dispersions with 0.04 to 0.09 in SD and 5 to 11% in CV. GAMA showed the smallest dispersion compared with the other method with statistical significance, the SD were 0 to 0.03 and CV were 1 to 4%.

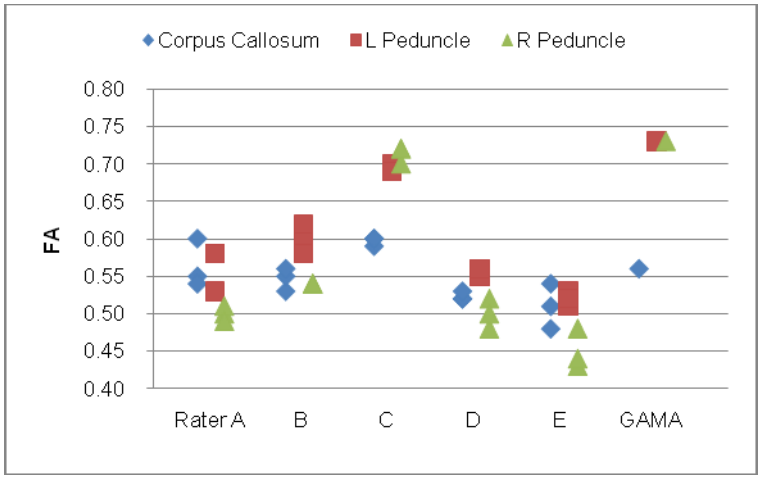

Fig. 2

Conclusion

Our novel method could evaluate FA automatically with high reproducibility in several analysis compared with the conventional ROI methods.