QUANTITATIVE CORRELATIONS BETWEEN GRAY MATTER VOLUME AND WHITE MATTER TRACTS IN FRONTAL AND OCCIPITAL REGIONS IN PRESCHOOL CHILDREN: ASSESSMENT COMBINED 3D T1WI AND DTI

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Introduction

Preschool period is an important stage for setting up brain function connection in motor, sensory, vision, language, and emotion. This complex process is closely related to the maturity and modifications in axons and neurons, which can be reflected in variations of both gray matter (GM) and white matter (WM). It's believed that there may be a close link between the two components. However, it is still lack of studies focusing on this. FreeSurfer is a powerful software which can automatically extract volume measurements based on three-dimensional T1 weighted images (3D T1WIs), and diffusion tensor imaging (DTI) can provide quantitative information of WM tracts. The aim of this study is to combine these two methods to primarily investigate the correlations between the variations of GM and WM in frontal lobe and occipital lobe during preschool period.

Methods

This study was approved by the local institutional review board. The neonates were sedated if necessary (oral chloral hydrate, 25-50 mg/kg) before MRI scanning. 7 normal children with ages range from 9 to 48 months who underwent MRI were enrolled. In this study, the three-dimensional magnetization prepared rapid gradient echo (3D-MPRAGE) T1 weighted images (T1WIs), fast spin echo (FSE) T2 weighted images (T2WIs) and DTI by single shot echo planar sequence were performed in a 3T scanner (GE, Signa HDxt,) with 8-channel head coil. DTI was performed by 35 directions, b value=1000s/mm^2, TR/TE=5500/95ms, slice thickness= 4 mm without gap, field of view = 180mm×180mm, matrix = 256×256, voxel size= 0.70×0.70×4mm^3. Extracted brain images were acquired using Brain Extraction Tool (BET, package in the FMRIB's Software Library (FSL)). MedINRIA was used to estimate the diffusion tensor of DTI image. Then FA of the diffusion tensor was calculated. White matter fiber bundles were tracked from the tensor field information. Parameters of fiber tracking used in this study are: FA threshold: 200, Smoothness: 20, Minimum Length: 10, Sampling: 1. Two independent ROIs that go through frontal cortex and occipital cortex (showed on **Fig.1 b**) was defined to extract fibers. Then the numbers of the extracted fibers were calculated automatically. Volume measurements of frontal lobe and occipital lobe were made using the freely valid software FreeSurfer (http://surfer.nmr.mgh.harvard.edu/).3D-MPRAGE T1WIs underwent preprocessing including intensity normalization and skull stripping, then segmentation and labelling of cortical and subcortical regions, automatically. Correlation coefficient between GM volume of frontal cortex, occipital cortex and age, numbers of fibers through these two cortexes and age, volume measures and number of fibers were all analyzed. Fiber numbers of frontal cortex and occipital cortex were regarded as dependent variables and age as independent variables when simple linear regression analyses were performed. All the math analyzes were performed using the MATLAB software(?).

Results

The results of segmentation of brain and fiber extraction were shown in **Fig.1.** The results of correlation analysis (seen in **Fig.2**) showed there were mainly strong positive correlations between GM volume of frontal cortex, occipital cortex and age, numbers of fibers through these two cortexes and age, and between GM volume and number of fibers. The correlation coefficients related with frontal cortex were all larger than them related with occipital cortex. In addition, it also can be found that the GM volumes and fibers though frontal cortex were all greater than them in occipital cortex.

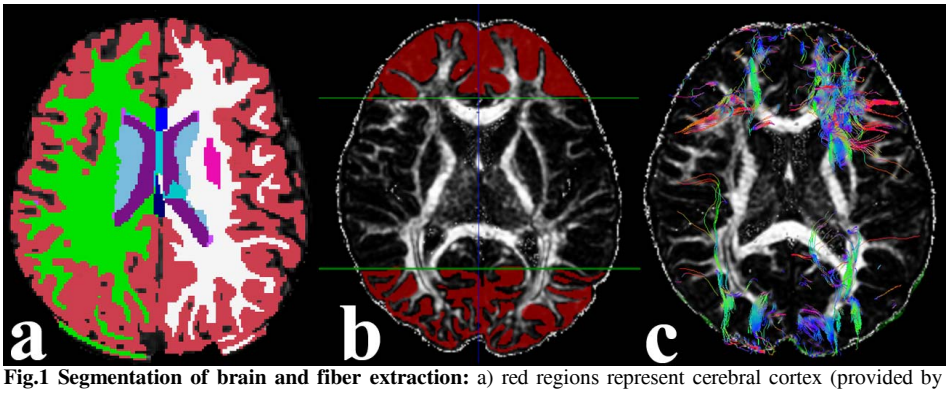

Fig.1 Segmentation of brain and fiber extraction: a) red regions represent cerebral cortex (provided by FreeSurfer) ; b) ROIs was manually drawn in the interventricular foramen slices of FA image ;c)the fibers extracted using the ROIs. red indicates a Left-Right orien-tation, green an Anterior-Posterior orientation and blue an Inferior-Superior orientation.

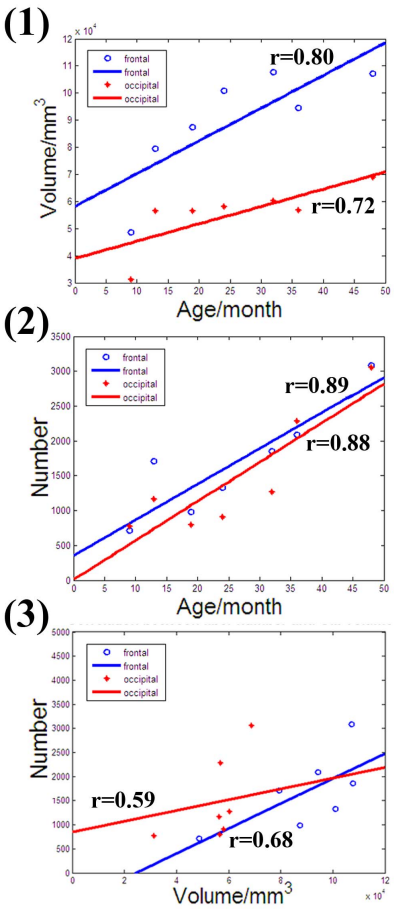

Fig.2 Simple linear fitting. Fig.1 Simple linear fitting: 1)shows how the GM volume of frontal lobe and occipital lobe vary with age ; 2) shows how the number of fibers go through frontal lobe and occipital lobe vary with age; 3) shows correlation between GM volume and corresponding fiber number. Blue and red color represents frontal and occipital massages respectively

Discussion & Conclusions

This study first demonstrated the positive relationship between GM volume in frontal cortex and occipital cortex and number of WM fibers through corresponding cortex in preschool children. GM volume of frontal cortex and fibers though frontal cortex were all greater than them in occipital cortex, was mainly due to its more complex function with greater surface relative to occipital cortex. The correlation coefficients related with frontal cortex were all also larger, which suggested that the development of frontal cortex was the relative dominant part during preschool period, for this is a critical stage for many complex human functions such as emotion and language development.

Acknowledgements: The authors would like to thank Drs. He Wang, Zhikui Xiao and Guang Cao from Applied Science Lab, GE Healthcare for their technical assistance. This study was supported by grants from National Natural Science Foundation of China (No.81171317 to JY).

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