Microstructure in Subcortical White Matter in Individual Cortical Regions : Age-related Changes after Adolescence

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Introduction

Numerous imaging studies have been reported regarding brain maturation in neonates and infants. On the other hand, only little is known about age-related structural changes of brain in adolescence and young adulthood. Diffusion-weighted imaging (DWI) has proven useful to visualize age-related microstructural changes in cerebral white matter. In this study, we used DWI to investigate age-related microstructural changes after the adolescence within the subcortical white matter in each cortical region.

Materials and Methods

DWIs of 16 healthy male subjects (age range: 12 to 47 years old, median 26.5 years old) were obtained using a 1.5 T MR scanner (Gyroscan Intera Achieva, Philips Medical Systems) and a CSF-nulled DTI pulse sequence with MPGs applied in 15 directions (TR/TE/TI=5300ms/68ms/2100ms, b=700s/mm^2). Fifty contiguous slices (2.5 mm thick) were obtained covering the whole brain. 3D mapping of mean diffusivity (MD) in subcortical white matter was performed using a previously reported method (1). To obtain mean MD values in each cortical regions, we used a free software package (Individual Brain Atlases using Statistical Parametric Mapping Software, IABSPM: Cuban Neuroscience Center), which automatically divides the gray matter into 116 regions according to the standard brain atlas. For our analysis, 76 cortical regions were selected discarding those in the cerebellum and deep gray matter. Mean MD value in each cortical region was correlated with age using Spearman's correlation coefficient.

Results

The 3D maps of subcortical MD showed age-related decrease in MD in the wide spread regions in the cerebrum (Fig. 1). A significant negative correlation between the mean MD value and age was observed in several cortical regions over the bilateral frontal, temporal and occipital lobes (Table and Fig. 2).

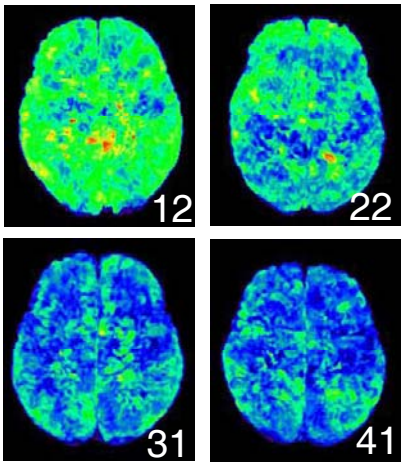

Fig. 1: 3D mapping of subcortical MD in 12, 22, 31 and 41 year-old subjects.

Region	r
L Precentral	-0.74
L Frontal_Inf_Operculum	-0.80
L Frontal_Inf_Tri	-0.74
L Frontal_Sup_Medial	-0.77
R Frontal_Sup_Medial	-0.75
L Occipital_Inf	-0.79
R Occipital_Inf	-0.81
L Fusiform	-0.73
R Fusiform	-0.80
L Postcentral	-0.75
L Temporal_Mid	-0.74
R Temporal_Mid	-0.73
R Temporal_Pole_Mid	-0.91
L Temporal_Inf	-0.76
R Temporal_Inf	-0.78

Red: p<0.05, Black: p<0.1
(corrected for multiple comparison)

Table: Brain regions in which mean MD value correlated negatively with age.

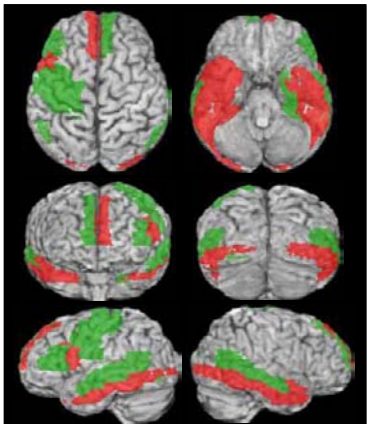

Fig. 2: 3D mapping of the tabulated brain regions.

Discussion

Our results demonstrated a continuing microstructural change in subcortical white matter in a period of adolescence and adulthood, which is in accordance with previously reported gross morphological analyses showing continuous growth of white matter volume into middle age (2). Decrease in MD in the medial frontal and inferior temporal and occipital regions are considered to reflect progression of myelination in these brain regions. The subcortical MD mapping in combination with IABSPM is useful to analyze age-related microstructural changes in the subcortical white matter in individual cortical regions.

References

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2. Bartzokis G, Beckson M, Lu PH, et al. Age-related changes in frontal and temporal lobe volumes in men: a magnetic resonance imaging study. Arch Gen Psychiatry 2001;58(5):461-465.