Brain Maturation in Early Adulthood: A Diffusion Tensor MRI Study

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Introduction

Previous MRI-based imaging studies have revealed dynamic developmental changes in the brains of newborns and infants, such as rapid progression of myelination. These changes slow down thereafter and become less obvious for qualitative observation. However, recent imaging and non-imaging studies have shown that brain maturation continues until early (or mid) adulthood. In this study, brain maturation in early adulthood was studied quantitatively using a diffusion tensor MRI technique.

Materials and Methods

Eighteen healthy adult subjects (20 - 38 years old, 9 males and 9 females) were studied using diffusion tensor MRI. A 1.5 Tesla clinical MRI imager was used with a standard head coil. The diffusion tensor sequence was a single-shot spin-echo echo-planar sequence. The imaging parameters were as follows: TR / TE = 5000 / 156 ms, b values = 0 and 1000 s/mm^2, NEX = 5. The diffusion-weighting gradients were applied in 6 directions. The image resolution was 2.34 x 2.34 x 6 mm^3. Twenty slices parallel to the AC-PC line covered the entire cerebrum. From the diffusion tensor data set, maps of mean diffusivity (MD) and fractional anisotropy (FA) were created. In the MD and FA maps, regions outside the cerebrum (cerebellum, brain stem, eye ball, CSF space, etc.) were removed by combined manual and automated procedures. From the two maps, histograms of MD and FA in the entire cerebrum were obtained, and the mean value, peak location, and normalized peak height of the two parameters were correlated with the subject's age.

Results

Significant correlation with age was observed in FA mean value (r = 0.506, p = 0.031) and normalized FA peak-height (r = -0.506, p = 0.031), respectively (Fig. 1). No significant age-related change in MD-related indices was seen.

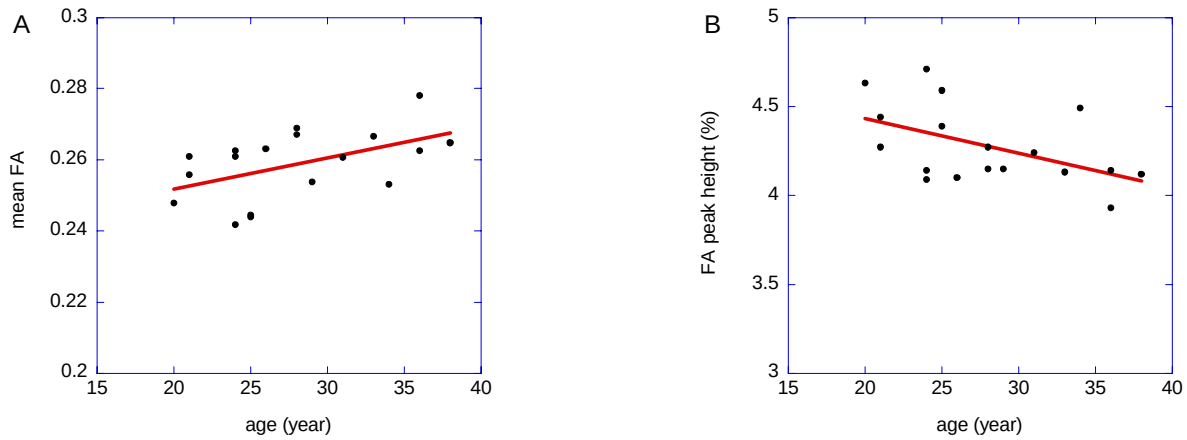

Fig 1: Age-related changes of (A) mean FA value and (B) normalized FA peak height of the cerebrum.

Discussion

Our preliminary results suggested that the human brain continues to mature in early adulthood, which is consistent with recent MR-volumetric studies. The positive correlation between age and mean FA value and the negative correlation between age and FA peak height may be accounted for by the continuous progression of myelination and/or the relative increase in white matter volume. Failure of MD indices to show significant age-related changes can be due to the lower sensitivity of MD than FA to reveal microstructural changes in the brain.

References

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