Age-related alterations of cerebral white matter: Analysis of normalized diffusion tensor images of healthy subjects grouped in narrow age ranges

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Background and purpose

Previous reports on age-related changes of fractional anisotropy (FA) of cerebral white matter were performed with subjects grouped in broad age ranges[1-3]. It is possible that more information about age-related effects on FA can be obtained through studies involving subjects grouped in narrower age ranges. In this study, age-related changes of cerebral white matter were evaluated, using normalized FA images of healthy subjects grouped in narrower age ranges.

Materials and Methods

The study included 132 healthy subjects (65 men and 67 women), aged 22-67 years. Diffusion tensor imaging (DTI) was performed with spin-echo echo-planar imaging sequence (TR/TE/NEX = 5100 ms/139 ms/2). The total number of non-collinear gradient direction was 12, and b-value (b) used was 1000 s/mm^2. FA maps were generated, and spatially normalized. The maps were then grouped into five, depending on age of the subjects. Comparison among age groups was performed, using region-of-interest (ROI)-based[1, 3] and voxel-based morphometry (VBM)[2] analysis. In ROI-based analysis, ROIs were placed at centrum semiovale, frontal and occipital white matter, anterior and posterior limbs of internal capsule, and genu and splenium of corpus callosum.

Results and Discussion

ROI-based analysis revealed of significant FA decline with age in all regions, except posterior limb of internal capsule (Fig 1). Age of initial significant FA decline differed among regions; frontal white matter experienced earlier FA decline. Increasing trend in FA, with a shift from the third to fourth decade, was observed in corpus callosum, frontal and occipital white matter. With VBM analysis, significant negative correlation between FA and age was noted only in frontal white matter and centrum semiovale (Fig 2). ROI-based analysis was more sensitive to FA decline with age, than VBM analysis. This may be attributable to methodological differences: in ROI-based analysis, ROIs are selected based on landmark and signal intensity of voxels within a ROI is averaged, whereas in VBM analysis, signal intensity in each voxel is analysed[4].

Our finding of FA decline with age is suggestive of microstructural changes of cerebral white matter[1], such as loss or decreased density of myelin structure, with aging. Earlier decline in FA of frontal white matter may reflect vulnerability of frontal white matter to normal aging.

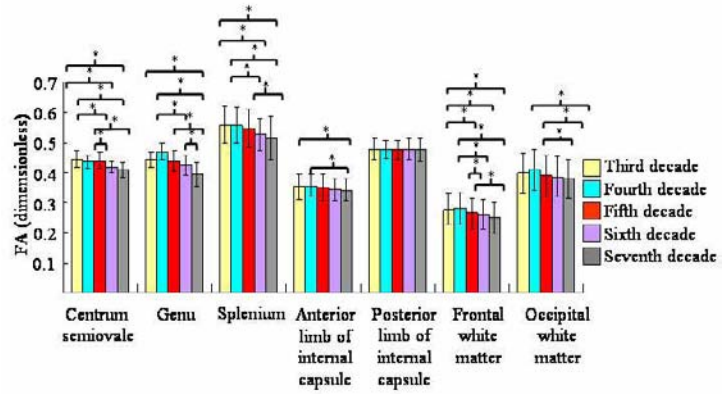

Fig 1. Results of ROI-based analysis. FA declines with age, except posterior limb of internal capsule. * represents statistical significance ($p<0.05$, two sample t-test).

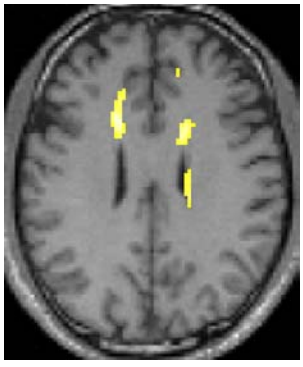

Fig 2. VBM analysis shows significant negative correlation between FA of frontal white matter, centrum semiovale and age (highlighted by yellow colour; $p<0.05$, linear regression).

Conclusion

Study on normalized FA images of subjects grouped in narrower age ranges provided information on age- and region-specific alterations of cerebral white matter. Results of ROI-based analysis and VBM analysis may differ.

References

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