Morphological changes in the major white matter fibre bundles: A 3D curve analysis

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ABSTRACT

Diffusion magnetic resonance imaging (MRI) provides an exclusive window on brain anatomy that allows exploring the brain's structural connectivity in vivo and non-invasive. Fibre tractography using diffusion MR imaging is a promising method for reconstructing the human brain white matter's 3D fibre (curve) architecture. Alzheimer's disease is a disconnection syndrome in which brain regions become physically and functionally detached one after the other as the disease progresses. Early identification of Alzheimer's disease, particularly in the pre-symptomatic period, is critical for slowing or preventing disease progression. Alzheimer's related structural and functional biomarkers have been developed by advanced neuroimaging techniques, such as positron emission tomography, structural MRI, diffusion MRI, and functional MRI. This research focuses on investigating the morphological changes in the Alzheimer's disease brain and developing a robust method for Alzheimer's detection using 3D curve analysis of the major white matter bundles. This is the first attempt to analyse the 3D curves in Alzheimer's disease prediction to the best of our knowledge. We have created six major fibre bundles from the Diffusion MRI of the Normal subjects and Alzheimer's subjects with many medical image processing steps such as pre-processing, registration, whole-brain fibre tracking, and segmenting the major bundles. We have presented visually and quantitatively; there are differences in major bundles in different features of the curves. For the quantitative analysis, the Delaunay triangulation method and average curves with geometrical features have been used to compare the normal subjects and Alzheimer's subjects statistically. The results show significant individual differences in each of the major bundles, reflecting the previous findings. In the future, we should analyse the biological reason for these differences.

Keywords: Alzheimer's disease, Average curve, Best curve, Delaunay triangulation, Diffusion magnetic resonance imaging, Major white matter fiber bundles, Three-dimension curve analysis. .