Detection of Abnormality in White Matter Fiber Bundles using DT MRI

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Abstract

Diffusion tensor magnetic resonance imaging (DT MRI) allows noninvasive evaluation of white matter (WM) microstructure in vivo. In this invited talk, after reviewing fundamental concepts of DT MRI, we present three state-of-the-art analysis methods for evaluating white matter fiber bundles in the brain. The first method, called tractography, extracts WM fibers in DT MRI data of an individual and allows their three-dimensional visualization and evaluation. The second and third methods, called voxel-based morphometry (VBM) and tract-based spatial statistics (TBSS), analyze DT MRI data of populations to quantitatively assess alterations in tracts attributable to neuronal damage or loss. To this end, DT MRI data volumes of different subjects are aligned to a standard space or atlas by an affine transformation and a mean image volume is generated. This process then identifies main WM fiber bundles. For the VBM, the mean fiber bundles of patients are compared with those of normal subjects while for the TBSS, the bundles are reduced to skeletons before the comparison is made. The above methods are applied to DT MRI data of temporal lobe epilepsy (TLE) patients and nonepileptic subjects. Affected WM tracts in TLE are identified and their alterations are quantified. To this end, diffusion parameters such as fractional anisotropy (FA) and ellipsoidal area ratio (EAR) are calculated and compared. Significant reductions of FA and EAR in epileptogenic temporal lobes are identified with marginal reductions in the hippocampus. Additional changes are noted in the corpus callosum and inferior frontal gyrus. Overall, this presentation illustrates that quantitative analysis of DT MRI data provides critical information for evaluating TLE.