

Altered Brain Wiring in Alzheimer's: A Structural Network Analysis using Diffusion MR Imaging

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Alzheimer's disease is a chronic neurodegenerative disorder and the most common form of dementia. It is characterized by cortical atrophy and disrupted anatomical connectivity as white matter fibre tracts lose axons and myelin degenerates. Biomarker tests are crucial to identify the early stages of the disease. It is currently a key priority in Alzheimer's research to develop neuroimaging biomarkers that can accurately identify individuals in any clinical stage of the disease. Magnetic resonance imaging (MRI) can be considered the preferred neuroimaging examination for Alzheimer's disease because it allows for accurate measurement of the 3-dimensional volume of brain structures. Diffusion Magnetic Resonance Imaging (DMRI), one of the methods, provides insights into aspects of brain anatomy that could never previously be studied in living humans. A comprehensive study of structural brain network in Alzheimer's has been developed using diffusion MR imaging and graph theory algorithms, that can assess the white matter connections within the brain, revealing how neural pathways damaged in Alzheimer's disease. A range of measurements of the network properties were calculated and the pattern of the community structure and the hub regions of the network were inspected. Global measures of efficiencies, clustering coefficients and characteristic path length confirms the disrupted overall brain network connectivity of Alzheimer's. Relatively the same pattern of hub regions is preserved in Alzheimer's, however, non-hub regions are affected, which indicates disease alters the internal pattern of the network especially the community structure. Modular analysis confirms this alteration and produces a different modular structure and increased number of modules in Alzheimer's. Regional connectivity measures also indicated this change and the measures demonstrated the network centrality shifted from right hemisphere to left in Alzheimer's. The knowledge gained from this study will support to find the strong imaging biomarkers of the Alzheimer's disease.

Keywords: Alzheimer's disease, brain network, Diffusion MR imaging, graph theory algorithms

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