Interwoven realms: Exploring whole brain diffusion tensor imaging variations in Alzheimer's disease and healthy controls

Nur Hafizah Mohad Azmi[1], Nur Shahidatul Nabila Ibrahim[1], Vengkatha Priya Seriramulu[1], Thilakavathi Karuppiah[4,5], Nur Farhayu Omar[1], Normala Ibrahim[3,7], Rizah Mazzuin Razali[8], Noor Harzana Harrun[9], Hakimah Mohammad Sallehuddin[3,4,10], Noor Alamshah B Bolhassan[11]

[1]Department of Radiology, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Selangor, Malaysia, [2]Pusat Pengimejan Diagnostik Nuklear, Universiti Putra Malaysia, Selangor, Malaysia, [3]Hospital Sultan Abdul Aziz Shah, Universiti Putra Malaysia, Persiaran UPM-MARDI, Selangor, Malaysia, [4]Malaysian Research Institute on Ageing, Universiti Putra Malaysia, Selangor, Malaysia, [5]Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia, [6]Department of Biomedical Sciences, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Selangor, Malaysia, [7]Department of Psychiatry, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Selangor, Malaysia, [8]Department of Medicine, Hospital Kuala Lumpur, Jalan Pahang, Kuala Lumpur, Malaysia, [9]Klinik Kesihatan Pandamaran, Persiaran Raja Muda Musa, Selangor, Malaysia, [10]Department of Medicine, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Selangor, Malaysia, [11]Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak, Sarawak, Malaysia

ABSTRACT

Introduction: Alzheimer's disease (AD) is a neurological condition, and late onset AD (LOAD) is the most prevalent form of dementia. It is a neurodegenerative condition defined by a gradual decline in memory function. Diffusion tensor imaging (DTI) is a technique used to study the movement of water molecules in the white matter of the brain. It provides information about the direction of axonal fibres and the overall structural integrity of the brain. DTI is not used as an alone diagnostic tool, but it helps in comprehending the evolution of AD by identifying changes in the white matter of the brain that indicate cognitive impairment, especially in regions associated to memory. Within the context of AD, deterioration of the structural integrity of white matter visualized on DTI, can non-invasively demonstrate aberrations in the fractional anisotropy (FA) and mean diffusivity (MD) of the tracts. DTI can be used to identify and measure these changes. The objective of our study was to identify the disparities in whole brain diffusion tensor imaging between individuals with AD and healthy controls (HC). **Materials and Methods:** A cross-sectional case control study was performed to compare the brain white matter integrity between AD and HC subjects in Klang Valley. The experiment was conducted using DTI and structural MRI imaging in the period between 2020 to 2023. We utilized FSL DTI processing as a computational approach in neuroimaging to extract meaningful data about white matter integrity in the brain among our subjects. We quantified metrics like FA and MD, after converting DICOM images into niffti.gz format, employing Python scripts within the FMRIB Software Library (FSL) to execute various tools and pipelines, including the Brain Extraction Tool (BET) and DTI Toolbox, tailored to individual study requirements. Quantitative measures of FA and MD were recorded and correlated with structural information of grey matter volume (GMV) atrophy, for regions of interest (ROIs) based on a priori knowledge, such as the hippocampus and posterior cingulate cortex (PCC), along with subject coordinates, facilitating comprehensive analysis and understanding of AD-related alterations in brain structure. **Results:** Higher MD values were detected in AD in comparison to the HC group, with a particular emphasis on the right and left hippocampus and PCC. These results correlated the presence of GMV atrophy in the selected ROIs. In contrast, the FA levels exhibited variations, with elevated values observed in the right hippocampus and PCC, while decreased values were found in the left hippocampus among AD. **Conclusion:** DTI imaging reveals a notable decrease in fractional anisotropy and an increase in median diffusivity in the temporal areas, which showed a significant correlation with AD phenotype. This method sheds light on microstructural changes in white matter pathways implicated in AD progression, potentially serving as biomarkers for disease advancement.