Exploring the association between age-related bilateral hippocampal volume distribution in Alzheimer's disease and normal ageing using VBM and HippoDeep methods

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ABSTRACT

Introduction: Alzheimer's Disease (AD) is a progressive neurological disorder that causes cognitive decline, memory loss, and behavioural changes. Hippocampus atrophy is strongly linked to AD pathogenesis. MRI is a useful tool for studying the hippocampus, and its volume can indicate neurodegenerative diseases like AD. A typical MRI analytic tool, Voxel-Based Morphometry (VBM), can detect very minor brain structural changes, making it beneficial for neurodegenerative disease research. HippoDeep, a deep learning-based device, can divide and measure the hippocampus, providing a precise insight of AD structural changes. Other studies have examined hippocampal volume changes in AD, but few have examined hippocampal volume distribution on both sides of the brain using advanced segmentation methods like HippoDeep and VBM. Due to age-related brain structure changes and the higher risk of Alzheimer's disease, age must be included as a covariate. This study will compare AD and HC bilateral hippocampus volume distributions using VBM and HippoDeep methods. We aim to improve our understanding of AD causes and create early diagnosis and intervention options. **Materials and Methods:** Comparison of bilateral hippocampus volume was done in a cross-sectional case control study. The study involved 15 AD and 15 HC subjects recruited from Hospital Kuala Lumpur and Hospital Sultan Abdul Aziz Shah, Universiti Putra Malaysia. Following the VBM methodology, segmentation produced a tissue class picture aligned with the original utilising the native space option. Normalising the tissue class image into a standard space and smoothing improved signal-to-noise ratio. For factorial design statistical analysis, images with identical dimensions, orientation, and voxel size were used. The Automated Anatomical Labelling toolset was overlaid on the Montreal Neurological Institute (MNI) template to obtain cluster-level volume. For HippoDeep, hippocampal volume segmentation methodology was used for automated segmentation. A sophisticated algorithm's output was used in transfer learning to train a model. The classifier was trained and tested using these simulated images. A Spearman rank correlation was calculated using VBM and HippoDeep Toolbox to examine hippocampus volume connection. Pearson correlation coefficient assessed the correlation of the two methods. Significance level set at <0.001. **Results:** By utilising HippoDeep, the disparity in volume was readily observed, since the linear discrepancy was far larger as compared to the VBM approach. The statistical significance was < 0.001 and provided 99.99% confidence level. This implied that HippoDeep has a higher level of sensitivity in detecting alterations in hippocampal volume in patients diagnosed with Alzheimer's disease when compared to VBM. **Conclusion:** Alzheimer's disease is a progressive neurodegenerative condition that calls for multimodal diagnostic instruments that are both accurate and efficient in characterising the disease. Through the utilisation of deep learning algorithms in the field of artificial intelligence automated measurements of hippocampal, a more accurate prediction of Alzheimer's disease can be achieved by combining various biomarkers.