Surface-based analysis of cortical thickness and volume loss in Alzheimer's disease

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Background and Hypothesis: Magnetic resonance imaging (MRI) has become a useful tool in monitoring the progression of Alzheimer's disease. Previous surface-based analysis has focused on changes in cortical thickness associated with the disease[1]. The objective of this study is to analyze MRI-derived cortical reconstructions for patterns of atrophy in terms of both cortical thickness and cortical volume. We hypothesize that Alzheimer's Disease progression will be associated with a more significant change in volume than thickness.

Experimental Design or Project Methods: MRI data was obtained from the Alzheimer's Disease Neuroimaging Initiative (ADNI). All subjects with baseline and two-year 3T MRI scans were included. Segmentation of MRIs into gray and white matter was performed with FreeSurfer[2,3,4,5]. Subjects whose scans did not segment accurately were excluded. Surfaces were then registered to a common atlas with Ciftify[6], and anatomically-constrained Multimodal Surface Matching (aMSM) was used to analyze longitudinal changes in each subject[7]. This produced continuous surface maps showing changes in cortical surface area and thickness. These maps were multiplied to create cortical volume maps[8]. Permutation Analysis of Linear Models (PALM) was used to perform two-sample t-tests comparing the maps of the Alzheimer's and control groups[9].

Results: Preliminary analysis of nine Alzheimer's subjects and nine control subjects produced surface maps displaying patterns that were expected given previous research findings[10,11]. There was increased volume and thickness loss in Alzheimer's subjects relative to controls, with relatively high loss in structures of the medial temporal lobe. Future analysis of a larger sample will determine whether statistically significant differences exist between the Alzheimer's and control groups in terms of thickness loss and volume loss.

Conclusion and Potential Impact: If significant results are found, surface-based analysis of cortical volume may allow for detection of atrophy at an earlier stage in disease progression than would be possible based on cortical thickness.

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