CORTICAL BRAIN SURFACE MAPPING FOR STUDYING PARTIAL VOLUME EFFECTS IN BRAIN FDG PET IMAGES

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Objectives

Due to the small thickness of cortical gray matter in the brain, biological interpretation of image values in the cortical regions on FDG PET images is confounded by tissue atrophy and partial volume effects, especially in patients with Alzheimer Disease (AD). In this study, we developed a method that employs a well established MRI-based cortical brain surface mapping technique to account for partial volume effects on brain FDG PET images, and demonstrated the method in a group of normal elderly subjects.

Methods

15 healthy elderly subjects without AD were included in this study. Both 3D MRI (SPGR) and FDG PET scans were performed on each subject. PET and MRI scans were mutually coregistered and aligned into the ICBM standard stereotaxic space, and cortical surface models were extracted from the MRIs. To better align data across subjects, each cortical model was elastically warped by aligning sulcal features in the 2D surface parameter space. The cortical thickness was computed from the distance between the gray matter/CSF and gray/white matter boundaries in the segmented MRI scan. At each cortical location the corresponding FDG value (normalized relative to the mean value for the whole brain)was evaluated. For each cortical point there is a distribution, across subjects, of FDG signal and cortical thickness. The correlation and the slope of a linear regression between FDG and cortical thickness were determined for each of these cortical voxels forming a correlation map across the cortex.

Results

There were areas of positive correlation throughout the brain, which largely reflects the partial volume effect. For these cortical regions, larger cortical thickness was associated with a higher metabolic rate. Correlation maps showed spatially variable patterns across the cortex. High positive correlation at the tip of the temporal lobe shows the strong influence of the partial volume effect, but in other parts of the brain there was little correlation indicating relative independence of the two signals. Compared to other regions, the high regression slope at the tip of the temporal lobe indicate that cortical thickness variations in that region are accompanied by large variations in FDG signal.

Conclusion

Aligning thickness maps derived from MR images and metabolism from FDG PET images in this way helps us gain new insight into the role of the partial volume effect on metabolic function measured in different brain regions. This method of evaluating cortical thickness along with metabolism will allow us to examine more critically metabolic changes in AD patients.

Supporting data

Figure 1 shows average maps computed from the scans of the 15 subjects. It shows the mean thickness and FDG values on the surface of the brain. The FDG values are all normalized relative to the average whole brain value of each subject. The FDG-thickness correlation maps for these same 15 subjects are shown as well. In addition, for each pixel we can estimate the slope of the linear regression between the two variables to see the extent of FDG differences relative to variations in cortical thickness on the brain surface. Regions with larger absolute values for this slope exhibit larger variations in FDG uptake for a given fixed change in cortical thickness.