A multimodal MRI investigation in patients with Alzheimer¡¯s disease, mild cognitive impairment, and cognitively normal subjects

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Introduction:

Advanced MRI techniques are widely used to investigate regional volume deficits, white matter damage, and altered cerebral blood flow associated with the vulnerability to mild cognitive impairment (MCI) and Alzheimer disease (AD). Similar observations of those structural changes become evidences as patients with AD go through the MCI to AD (1-3). Voxel-based morphometry (VBM) is one method developed for automated analysis of structural MRI scan. It has been used analysis of brain tissue loss in AD (1, 4). In addition, some reports represents the role of diffusion-tensor imaging (DTI) in the evaluation of WM damage is well being established and DTI has the potential to emerge as a useful diagnostic tool of MCI and AD (2, 3, 5). Recent reports had demonstrated reductions of regional cerebral blood flow (rCBF) in subjects with AD and MCI (6-8). The purpose of our study was to prospectively evaluate if the gray matter (GM) loss, the diffusion anisotropic change, the cerebral perfusion reduction demonstrate a pattern of concordance or dissociation in subjects with AD and MCI, compared with cognitively normal (CN) subjects.

Materials and Methods:

Institutional review board approval and informed consent were obtained. Twenty-six subjects with AD (four men, 22 women; mean age, 71.3 years), 26 with amnestic MCI (13 men, 13 women; mean age, 67.8 years), and 26 CN subjects (10 men, 16 women; mean age, 68.9 years) underwent isotropic volumetric T1-weighted imaging, DTI with 32 directions and b-values of 0 and 800 sec/mm2, and pulsed arterial spin labeling (ASL)-MR imaging, mainly in the parietal and temporal lobes. Pre-processing steps were performed with SPM5 software and voxel-based statistical analyses among groups were performed on GM volumes, fractional anisotropy (FA), trace diffusivity (D), and CBF by one-way ANOVA tests in using SPM5. The results were corrected for multiple comparisons using a false discovery rate (FDR) of 1% with a threshold looking for clusters with at least 10 contiguous voxels for GM volumes and FDR of 5% with a threshold looking for clusters with at least 10 contiguous voxels for FA and D. For group difference in perfusion, significance level of $p < 0.005$ without correcting multiple comparisons was applied.

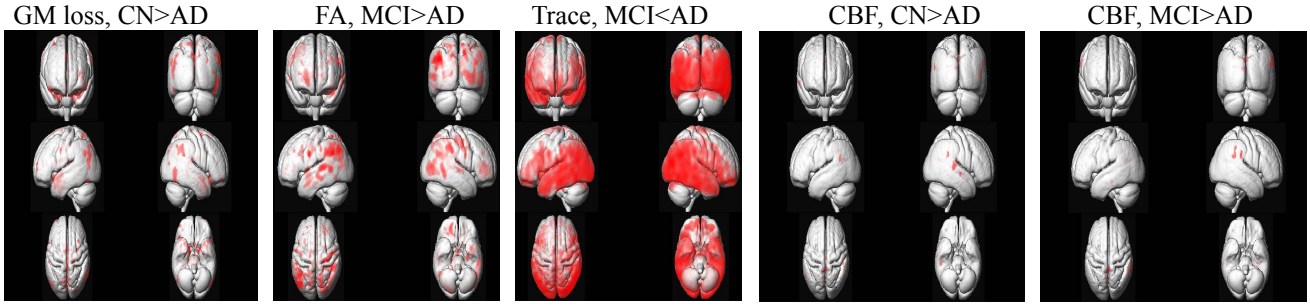
Results:

There was significantly reduced regional GM volumes in AD compared with CN, mainly including the bilateral temporal lobes, the bilateral frontal lobes, the bilateral parietal lobes, the bilateral parahippocampal gyri, the bilateral cingulums, the bilateral thalami, the bilateral basal ganglias, and the right insula. GM volumes in AD compared with MCI were reduced in the right amygdala, the right inferior frontal gyrus, and the right cuneus. For FA between AD and CN or between AD and MCI, FA reduced mainly in the bilateral temporal lobes, the bilateral frontal lobes, the bilateral parietal lobes, the bilateral lingual gyri, the bilateral cingulums, the left parahippocampal gyrus, the left insula, and the left thalamus. For D, there were significantly increases in AD compared with CN, mainly in the bilateral temporal lobes, the bilateral parahippocampal gyri, and the bilateral cingulums. D were also increased AD compared with MCI, mainly in the bilateral temporal lobes, the bilateral occipital lobe, the bilateral parahippocampal gyri, and the right cingulum. The regional hypoperfusion was showed in AD in the bilateral temporal lobes, the bilateral parietal lobes, and the bilateral cingulums and in MCI in the right subthalamic nucleus compared with the CN. Additionally, CBF in MCI compared with CN was increased in the left parahippocampal gyrus.

Discussions and Conclusion:

Multimodal investigations can demonstrate the pattern of concordance or dissociation in patients with AD and MCI. Concordance areas of GM loss and the diffusion anisotrophic change of AD and MCI were mainly in the bilateral temporal lobes, the bilateral cingulums, the right parahippocampal gyrus, and the bilateral parietal lobes. Overlapping patterns of progression of structural and microstructural damage were observed. Concordance areas of structural change, microstructural change, and CBF were the bilateral cingulums and the left precuneus. The data of our study support the hypothesis that structural changes and CBF changes were associated in the pathogenesis of AD and MCI. The combination of different neuroimaging modalities will great enhance ability to detect brain changes in AD and MCI.

Fig.1. Results of GM loss , diffusion change, and CBF alternations among three groups



References: 1. Busatto, G.F. et al. Expert Rev Neurother, 2008. 8(11): p. 1691-702. 2. Chua, T.C. et al. Curr Opin Neurol, 2008. 21(1): p. 83-92. 3. Stahl, R. et al. Radiology, 2007. 243(2): p. 483-92. 4. Karas, G.B. et al. Neuroimage, 2003. 18(4): p. 895-907. 5. Bozzali, M. et al. Magn Reson Imaging, 2007. 25(6): p. 969-77. 6. Luckhaus, C. et al. Neuroimage, 2008. 40(2): p. 495-503. 7. Asllani, I. et al. J Cereb Blood Flow Metab, 2008. 28(4): p. 725-36. 8. Johnson, N.A. et al. Radiology, 2005. 234(3): p. 851-9.