Diagnosis of Alzheimer's Disease: Combined ASL Blood Flow Measurement and Morphometric Imaging

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Introduction

It is increasingly recognized that neuroimaging plays an important role in diagnosing Alzheimer's disease (AD). Both structural information provided by MR imaging and functional information by SPECT/PET have proven useful in diagnosing AD. Arterial spin labeling (ASL) is a unique MR imaging technique that allows for non-invasive measurement of cerebral blood flow (CBF). With the spread of 3 T imaging, ASL is becoming a clinically available tool. In this study, we investigated the feasibility of combined ASL CBF measurement and morphometric imaging in one MR examination and assessed its efficacy in diagnosing AD.

Materials and Methods

Twenty AD patients (10 males and 10 females, mean age=73.5 years, MMSE=11-25) and 23 cognitively normal old subjects (11 males and 12 females, mean age=72.9 years, MMSE=27-30) were studied using a 3T MR scanner (Achieva, Quasar Dual, Philips Medical Systems). CBF measurement was performed using a quantitative ASL method (QUASAR): labeling slab=150mm, FOV=230mm, matrix=64x64, TR/TE=4000ms/22ms, sampling interval=300ms, 13 time points, 7 slices, slice/gap=7mm/1mm, Venc=4cm/s, imaging time=5min52s. CBF maps were normalized by values in the sensorimotor cortex, which is known to be resistant to AD pathology. Regions of hypoperfusion due to AD were determined using statistical parametric mapping (SPM) analysis. High-resolution T1-weighted images (3D MPRAGE, imaging time=5min20s) were obtained for morphometric measurement. Regions of gray matter atrophy were determined following the scheme of the voxel-based morphometry (VBM). Discrimination of AD patients from healthy control subjects was attempted separately based on (1) the mean CBF values in hypoperfused region and (2) the mean gray matter density in atrophied region. In addition, discrimination was attempted based on (3) a linear discriminant function based on CBF and gray matter density. ROC analysis was used to evaluate the discriminating abilities of the three diagnostic methods.

Results

Fig 1 shows regions of hypoperfusion and decreased gray matter density determined by SPM methods. Fig 2 shows the results of ROC analysis for discrimination. The area under curve (AUC) value and the accuracy for the CBF alone were 0.932 and 86.0 %, respectively, while those for the gray matter density alone were 0.946 and 88.4 %. Combination of CBF and gray matter density resulted in a higher AUC value (0.990) and accuracy (93.0 %).

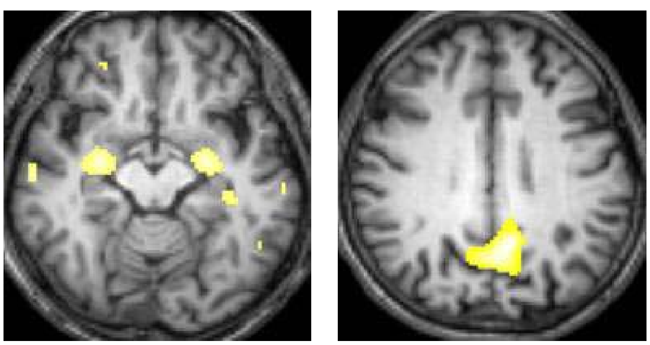

Fig 1: Regions of hypoperfusion (left) and decreased gray matter density (right) determined by SPM methods.

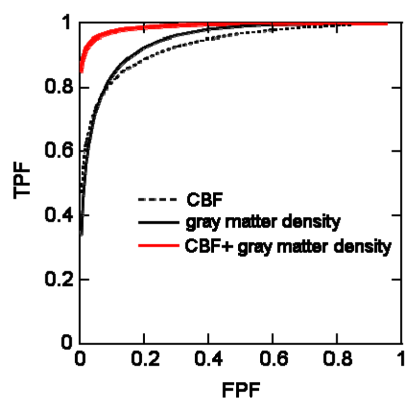

Fig 2: Results of ROC analysis for discrimination for three diagnostic methods.

Discussion

ASL CBF measurement and morphometric imaging together required only approximately 11min and could be easily performed in one MR examination. Discriminating abilities of CBF and gray matter density were comparable. Combined use of CBF and gray matter density may increase the diagnostic accuracy for AD.

References

Johnson NA et al. Radiology 2005;234:851-859. Petersen ET et al. Magn Reson Med 2006;55:219-232. Kawachi T et al. Eur J Nucl Med Mol Imaging 2006;33:801-809.