# Cerebral Perfusion in Alzheimer's Disease using Dynamic Susceptibility Contrast MRI

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## Introduction

A decrease in cerebral perfusion has been observed with perfusion MRI in Alzheimer Disease (AD) [1], the most common of the neurodegenerative diseases. Since these and subsequent studies have used arterial spin labeling techniques, the application of DSC perfusion with intravenous gadolinium contrast injection to investigate perfusion changes in AD has received only limited attention. It may be clinically advantageous to develop DSC further because the technique can be performed rapidly, provides cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT) maps, and is less sensitive to normal age-dependent reductions in blood flow. Moreover, the clinical workup for dementia often already includes imaging with gadolinium contrast agents. However, conventional DSC MRI with indicator-dilution modeling techniques have limited accuracy due to inadequate temporal resolution, partial volume artifacts and non-linearity in MR signal as a function of contrast agent concentration. Recent approaches have made DSC MRI more quantitative using estimates of blood volume in the steady-state [2,3]. The purpose of this study is to determine the feasibility of DSC perfusion MRI for the detection of qualitative CBV and CBF changes in subjects with AD with an overall goal of quantifying these changes with novel DSC MRI techniques.

## Materials and Methods

Seven subjects with AD (4 men, 3 women, mean age 76.9 years) and six Control Normal subjects (3 men, 3 women, mean age 71.5 years) were scanned on a GE Signa 1.5T MR. The imaging protocol included two injections of contrast agent. One relatively rapid bolus injection (65 μmol/kg at 3 mL/s) followed by a slow infusion (35 μmol/kg at 1 mL/s). For the bolus technique, the acquisition parameters were optimized for depicting temporal dynamics: TR of 1150 ms, TE of 35 ms, Flip angle of 90°, 12 slices, and thickness of 5 mm with a gap of 1 mm [4]. Slices were angled obliquely parallel to the base of the temporal lobe to maximize coverage. However, the total coverage of ~8 cm did not always cover the top of the parietal lobe. The Perfusion maps were calculated by first selecting the arterial input function (AIF) followed by deconvolution with block-circulant SVD [5]. CBV, MTT, and CBF perfusion maps were normalized to standard MNI space and smoothed with a 10mm FWHM Gaussian kernel using SPM5 [http://www.fil.ion.ucl.ac.uk/spm/]. A two-sample t-test was implemented voxel-by voxel and thresholded at p<0.0005 comparing the Control Normal group to the AD group for differences in CBV, CBF, and MTT.

## Results

For the CBV comparison, the AD group showed hypoperfusion compared to the Control Normal group in the posterior cingulate cortex with the maxima located at (-6, -52, 34) in units of mm, T value = 8.82, p-value <<0.001. Hypoperfusion was also shown in the lateral parietal cortex and left posterior para-hippocampal gyrus of the AD group (Fig. 1). For the CBF comparison, hypoperfusion was shown in the posterior cingulate with a maxima located at (-4, -54, 36) in units of mm, T value = 11.24, p-value <<0.001 (Fig. 2).

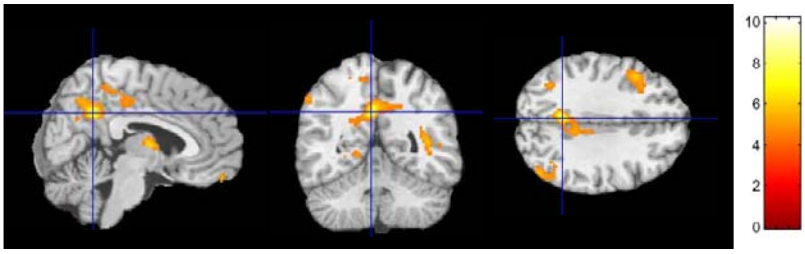


Fig 1. Statistical Parametric Maps of cerebral blood volume hypoperfusion in AD group (p<0.0005). Color bar indicates T-statistic.

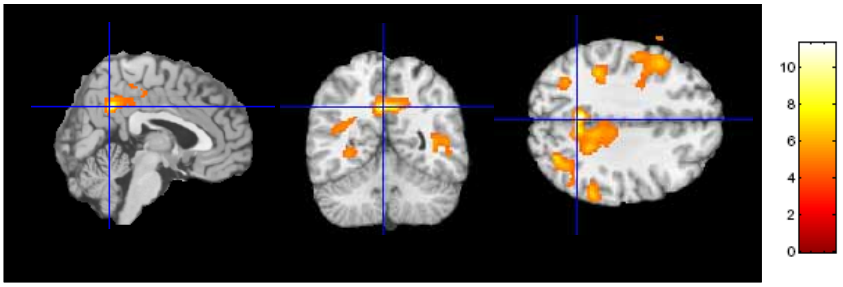


Fig 2. Statistical Parametric Maps obtained from cerebral blood flow of hypoperfusion in AD subjects (p<0.0005). Colorbar indicates T-statistic.

## Discussion

The data support DSC MRI as a viable means for measuring relative perfusion changes in AD. The regions of hypoperfusion identified in the AD subjects are consistent with prior studies using ASL and PET perfusion methods [1]. Future processing will include quantitative measurements using the infusion technique [3]. Specifically, quantitative CBF maps will be obtained by scaling the calculated flow values using the independent measurement of blood volume derived from a steady-state infusion measurement.

**Conclusion** This dynamic susceptibility contrast technique shows promise for identifying hypoperfused areas in subjects who have AD and those at risk for developing AD.

## References

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## Acknowledgements

This research was supported by:

- National Institute of Neurological Disorders and Stroke (NINDS). 1F31NS52971-01
- NIA R01 AG21155 and by a Merit Review grant from the Department of Veterans Affairs