

Conductivity Change After MRI Contrast Agent Injection in the Brain of Alzheimer's Disease

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- White Matter Conductivity Increases as Cognitive Impairment Progresses
- Conductivity Heterogeneity Indices Effectively Differentiate MCI and AD from Normal Brains
- Linear Patterns in GBCA Leakage Map Vascular Damage

Background:

Magnetic resonance electrical properties tomography (MREPT) visualizes the conductivity distribution of biological tissues at the Larmor frequency using the B1 field phase signal. Currently, no studies have investigated brain conductivity changes following gadolinium-based contrast agent (GBCA) injection in patients with Alzheimer's disease (AD).

Objective:

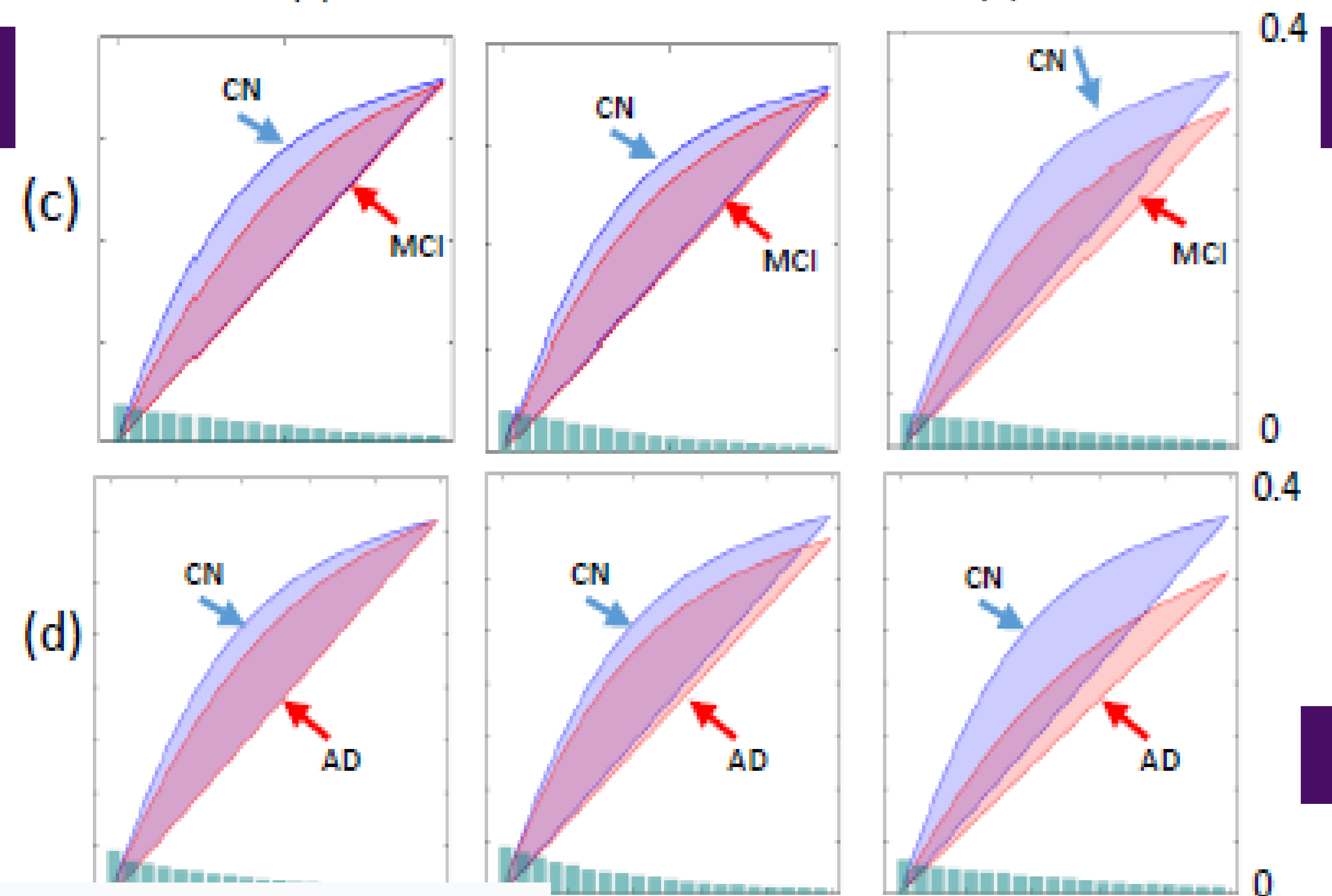
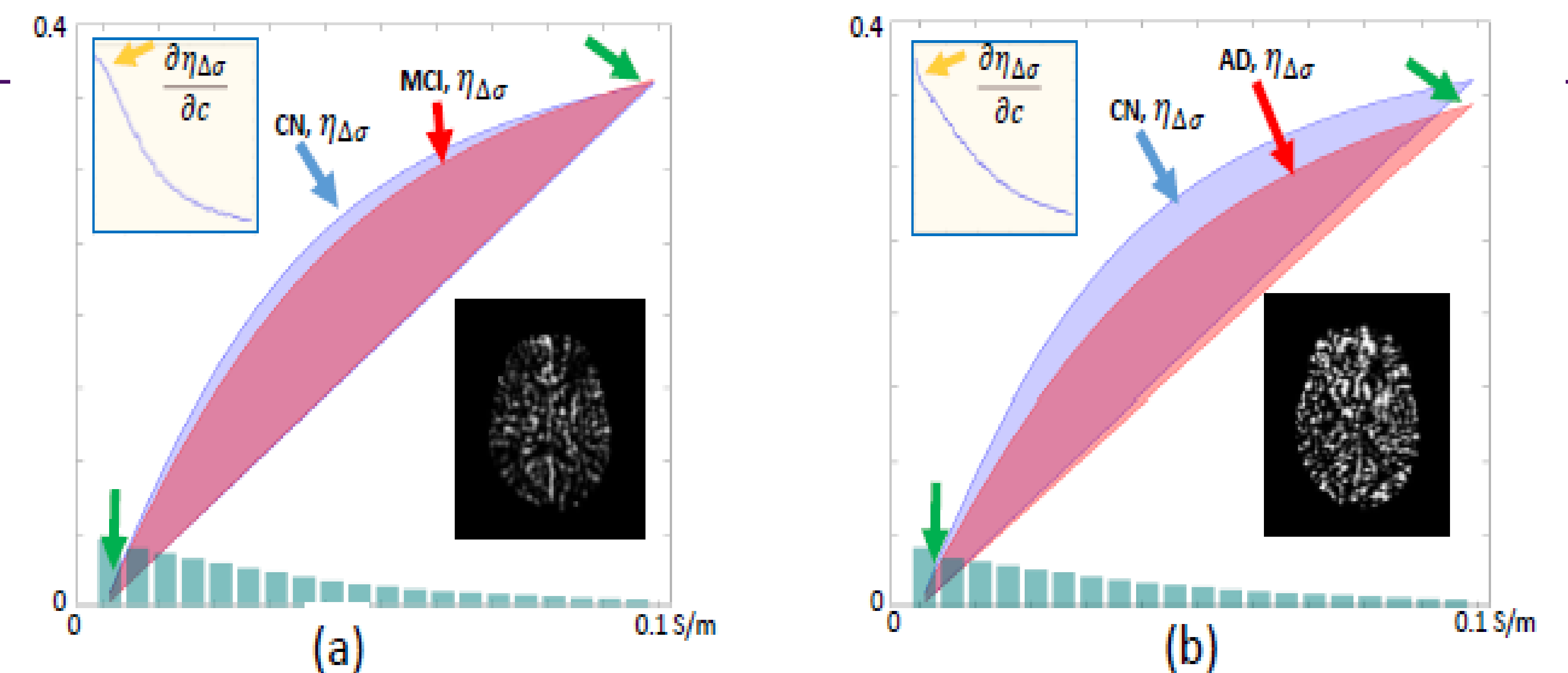
This study aimed to examine the effects of GBCA on brain conductivity changes and to compare differences in conductivity maps before and after GBCA injection between AD or mild cognitive impairment (MCI) and cognitively normal (CN) participants.

Method

- To investigate vascular damage in AD, we defined the conductivity heterogeneity volume fraction (CHVF) index as an indicator of GBCA leakage-induced vascular damage. Using CHVF, we developed three indices to characterize MCI (**Fig. 1a**) and AD (**Fig. 1b**).
- To validate the proposed method, we studied 42 participants, including 14 with AD, 18 with MCI, and 10 cognitively normal (CN) participants. Conventional multi-echo gradient-echo data were obtained from all participants using a 3 T MRI scanner.

CHVF Diagnostic Indices Defined:

- **Area Index ($M_{\eta\Delta\sigma}$):** Total normalized volume fraction reflecting time-dependent agent diffusion across disrupted tissues.
- **Initial Slope (b^{bg}):** Corresponds to capillary vascular density and initial leakage speed.
- **Terminal Slope (b^{ed}):** Reflects interstitial clear-out rate and degree of terminal microvascular breakdown.



CONCLUSION & VISION

- **White matter conductivity (σ_{wm})** exhibits a significant progressive increase matching neurodegeneration severity.
- Linear patterns in GBCA distribution (smaller Area Index) directly capture advanced BBB permeability damage.

- **MREPT-CHVF parameters** act as a viable, accessible physiological marker to successfully differentiate early MCI from healthy controls.

Reference
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