PET-MR compatible CEST method for imaging of Alzheimer's Disease

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INTRODUCTION:

PET scans are the gold standard for detecting amyloid deposits in the brain[1]. CEST imaging may provide alternative or complementary information to PET imaging. However, typical CEST experiments utilizes long RF saturation that is not compatible with the PET-MR hybrid system. The aim of this study is to address this limitation by developing a steady-state CEST MRI method that allows CEST imaging to be acquired during PET sessions.

METHODS:

Our CEST sequence incorporates steady-state RF saturation with stack-of-stars golden-angle radial sampling[2]. There is no delay between the acquisitions, ensuring the attainment of a steady-state saturation condition. Gaussian pulses were used for CEST labeling with a B1 = 0.5 µT, duration of 50 ms, followed by a spoiling period (20 mT/m, 5 ms). Images were acquired at 32 saturation frequency offsets between -8.1 to 3.0 ppm, along with two reference images. 100 radial stacks were acquired at each frequency offset, corresponding to a total scan time of 5.5 min. The study was approved by the Mount Sinai institutional review board and was conducted on individuals with mild cognitive impairment and age matched controls. GRASP-Pro technique was performed to reconstruct the dynamic images[3]. rNOE Lorentzian difference (LD_{noe}) maps were generated by computing Lorentzian difference within the range of -3.2 to -3.8 ppm. The ΔST(-3.6 ppm) maps[4] were calculated by taking the difference between the signal at -8 and -3.6 ppm. Amyloid PET was acquired using 18F-labeled florbetaben (Neuraceq). The amyloid SUVR map was calculated using cerebellum gray matter as reference region. Both CEST and PET images were co-registered to the anatomical T_1 images.

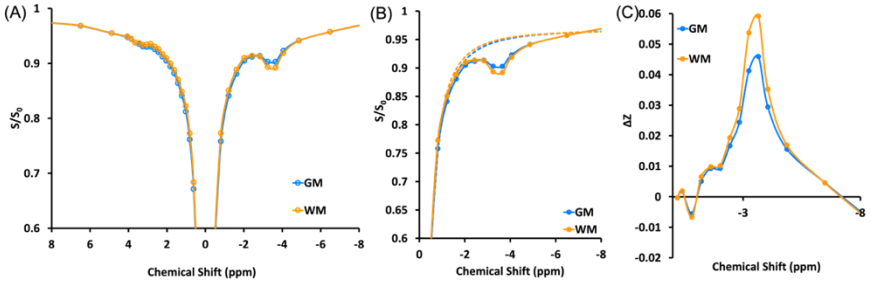

Fig. 2. (A) The z-spectrum acquired with the ST MRI sequence in the gray and white matter regions; (B) The negative side of the acquired z-spectrum and the Lorentzian fitted spectrum; (C) the Lorentzian difference spectrum.

RESULTS:

Two ROIs were delineated, representing the white matter (WM) and the gray matter (GM) areas. Fig. 1A shows the full z-spectra in the GM and WM. A Lorentzian line was fitted to the negative side the z-spectrum (dotted line in Fig 1B) and rNOE effect can be isolated by taking the difference between the Lorentzian fitted spectrum and the acquired z-spectrum (Fig. 1C). Fig. 2. shows T1-weighted, LD_{noe}, ΔST(-3.6 ppm) and amyloid SUVR maps of an Aβ negative, and an Aβ positive individual, respectively.

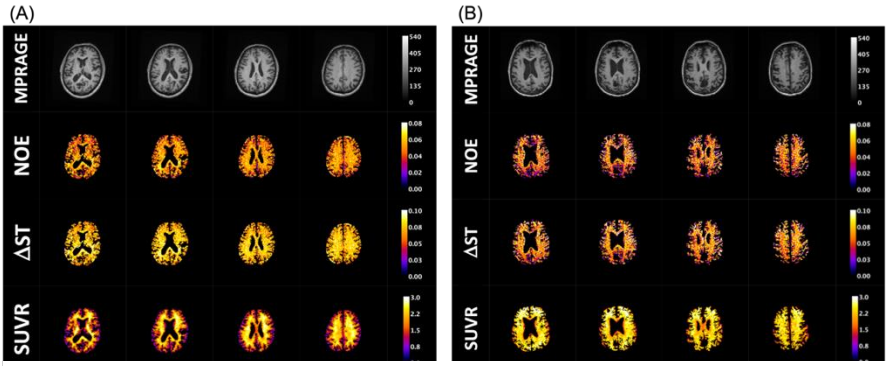

Fig. 1. From top to bottom: Co-registered T1 MPRAGE, LD_{noe} maps, ΔST(-3.6 ppm) maps and the Aβ SUVR maps for (A)an Aβ negative individual and (B) an Aβ positive individual.

DISCUSSION:

The method can provide excellent rNOE contrast, potentially sensitive to beta-amyloid aggregates. Compared to healthy controls, the AD/MCI patients appeared to have narrower distributions of LD_{NOE} and ΔST and a trend for higher values. Ongoing work includes increase subject accrual and correlation of the CEST and the Aβ PET.

CONCLUSION:

We demonstrated the implementation of a steady-state, radially acquired imaging sequence that is fully compatible to the hybrid PET-MR system. The method is potentially sensitive to Aβ deposition, but more data is needed to validate the findings.

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