Practical quantitative zoomed DTI of medial temporal lobe structures using a 2-channel parallel transmit coil.

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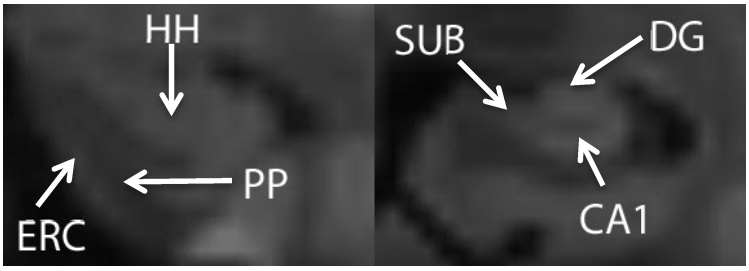
TARGET AUDIENCE: Clinicians and researchers interested in quantifying early disease-specific diffusion changes to particular structures within the medial temporal lobe.

INTRODUCTION: The hippocampus and entorhinal cortex form a critical neuronal circuit for declarative memory formation altered by different pathologies, including Alzheimer's disease. Unfortunately, standard single-shot echo-planar diffusion tensor imaging (DTI) fails to characterize the medial temporal lobe structures and their functional connectivity well due to geometric distortions from subjacent temporal bone airspaces. This study used 2D-selective RF excitation from a 2-channel parallel transmit system (pTX) [1] to overcome these distortions at 3-T and quantify diffusion tensor properties for specific medial temporal lobe structures.

METHODS: 5 healthy human volunteers were scanned on a 3-T MAGNETOM Skyra (Siemens AG, Healthcare Sector, Erlangen, Germany) with a prototype 2-channel pTX and 20-channel head/neck receive coil. Single-shot EPI diffusion-weighted images with fat saturation were obtained (TR/TE = 2200/83 ms, NEX = 15, time = 8 min, 10 gradient directions, b=800 s/mm^2) using a 2D-selective RF pulse that allows inner volume excitation and thus reduced field-of-view images [1]. The protocol used a 13.3 x 4.4-cm field-of-view (read x phase axes) with 1.5-mm in-plane resolution (90 x 30 image matrix). 18 contiguous 3-mm thick oblique coronal slices were obtained orthogonal to the long axis of the temporal lobe with the most posterior slice prescribed tangential to the vertical portion of the hippocampal tail.

RESULTS: Zoomed diffusion-weighted images had acceptable signal-to-noise (6.6 ±1.1 @ b=800 s/mm^2) and significantly reduced geometric distortions from subjacent temporal bone airspaces compared to full field-of-view acquisitions. Diffusion-weighted images resolved specific components of the medial temporal lobes such as the entorhinal cortex (ERC), perforant pathway white matter (PP), hippocampal head (HH), subiculum (SUB), dentate gyrus (DG), molecular and neuronal layers of the hippocampus (CA1)(see figure). Quantitative data (table) was consistent with prior DTI parameter values from human hippocampus autopsy samples [2]. Color fiber orientation maps demonstrated coherence from CA1 neuron apical dendrites as previously shown [2] and data may allow tractography of the perforant pathway between the entorhinal cortex and hippocampus.

DISCUSSION: 2D-selective RF excitation on a 2-channel pTX system enables zoomed DTI acquisitions on 3-T scanners that can resolve the diffusion properties for different components of the medial temporal lobes that are typically obscured by susceptibility artifacts. This approach is comparable to previous zoomed DTI acquired with outer volume suppression [3] and may be more practical than complex, custom MRI acquisition techniques [4] recently used to investigate the medial temporal lobe. The next goal is to determine if this approach could provide novel surrogate imaging markers for epileptogenic seizure localization and/or early functional connectivity changes preceding Alzheimer's disease.



Region	Mean diffusivity (x 10^{-3} mm^2/s)	Fractional Anisotropy
CA1	0.82 ± 0.04	0.25 ± 0.06
DG	0.86 ± 0.06	0.27 ± 0.06
ERC	0.77 ± 0.08	0.32 ± 0.07
PP	0.81 ± 0.07	0.40 ± 0.08

REFERENCES: 1. Schneider et al. Proc ISMRM 2012. 2. Shepherd et al. AJNR 2007;28:958-964. 3. von Morze et al. MRI 2010;28:1541-1545. 4. Zeineh et al. Neuroimage 2012;62:2065-2082.