

High-resolution 7T MRI and MRSI in patients with suspected mesial temporal epilepsy

Peter B Barker¹, Gregory K Bergey², Huong Trinh³, Tilak Ratnanather³, He Zhu⁴, David Bonekamp⁵, and Doris D.M. Lin⁵

¹Radiology, JHU SOM, Baltimore, MD, United States, ²Neurology, JHU SOM, MD, United States, ³Center for Imaging Science, JHU, MD, United States, ⁴Radiology, Vanderbilt University, TN, United States, ⁵Radiology, JHU SOM, MD, United States

Target audience: This study will be of interest to clinicians and researchers who use MRI and MR spectroscopic imaging (MRSI) to evaluate patients with temporal lobe epilepsy.

Purpose: Resective surgery may provide effective seizure control in patients with drug-resistant partial epilepsy. Successful outcome relies on the accurate presurgical identification of the seizure foci; traditionally this is performed using ictal EEG monitoring in conjunction with imaging such as MRI and PET, and other modalities. Patients with unremarkable imaging often require intracranial EEG (iEEG) monitoring to accurately delineate the seizure focus. Currently up to ~30% of conventional 1.5 or 3.0T MRI scans are considered negative in patients with a final diagnosis of mesial temporal lobe epilepsy (mTLE)¹. This study was undertaken to assess whether higher resolution MRI and MRSI scans available at 7T could more accurately diagnose patients with mTLE. Improved detection of mesial temporal abnormalities with imaging could allow more patients to proceed to temporal lobectomy without requiring iEEG, a procedure with appreciable risks.

Methods: 17 patients (10 M, 32 ± 12 years) with suspected mTLE, and 7 normal control subjects (4 M, 34 ± 11 years) were enrolled. Full clinical workup included PET, intracranial EEG, clinical 3T MRI and pathology (in surgical cases). Final clinical diagnoses in the patient group were: 11 mTLE (8 abnormal 3T MRI, 3 normal), 6 neocortical/extratemporal. MR was performed on a Philips 7T 'Achieva' System equipped with a 32-channel head coil (Nova Medical). A sagittal MPRAGE 0.6 mm isotropic resolution (13 min scan time, 2 NEX, 300 slices, TR/TE/TI = 4.7/2.1/446 ms, FA 7°) was performed and hippocampal (including subfield) volumes measured. VAPOR water suppressed 2D STEAM-MRSI of the bilateral temporal lobes was also performed, with the following parameters: TR/TE/TM 2500/23/20 ms, high order shimming, 10 mm slice thickness, FOV 220x178 mm, matrix 32x26, nominal voxel size ≈ 0.4 cm³, circular k-space sampling, SENSE factor 2, giving a scan time of 12 min 25 sec. A separate water reference acquisition was also collected (scan time 5 min 30 sec). Spectra were quantified using LCModel analysis.

Results: Figure 1 shows an example MPRAGE image in one patient. Figure 2 shows the results of hippocampal volume analysis in all subjects. Figure 3 shows hippocampal NAA and NAA/Cr ratios in controls, mTLE and neocortical patient groups. Volumetric 7T MRI measurements correctly lateralized side of seizure onset in all studies that were considered abnormal at 3T (figure 2); in addition, it correctly identified abnormal hippocampi in 2 out of the 3 studies that were read as normal at 3T. These results are promising for the use of 7T MRI in the presurgical evaluation of mTLE. Consistent with previous studies², 7T MRSI showed bilateral decreased mid-hippocampal [NAA] ($p < 0.001$) and NAA/Cr ($p = 0.014$), with a non-significant trend for greater NAA reduction in the ipsilateral compared to contralateral hippocampus. Because of contralateral reductions, MRSI had limited value for lateralization; however, clear asymmetries were observed in some cases. Since hippocampal [NAA] was normal in the neocortical cases, this could perhaps be used to distinguish mTLE from neocortical epilepsy.

Discussion: These results suggest a promising role for 7T MRI and MRSI in the presurgical evaluation of patients with suspected mTLE. Of particular note was the volumetric asymmetry detectable (greater than that seen in any control subject, and correctly lateralizing) in 2 of 3 patients whose clinical 3T MRI scans were read as normal. Additional studies in patients with normal 3T MRI scans are needed to confirm the added value of performing 7T MRI in this group.

Acknowledgements: Supported in part by the Johns Hopkins Brain Sciences Institute and NIH P41EB015909.

1. Mueller et al. Epilepsia, 50(6):1474–1483, 2009, 2. Hetherington et al. Neurology 2007;69:2256–2265

