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Differences between Left and Right Mesial Temporal Lobe Epilepsy Using Resting-State Network fMRI and SEEG Connectivity

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Introduction: The most common type of surgical epilepsy is mesial temporal lobe epilepsy (mTLE). Due to rapid contralateral spread, lateralization of mTLE is challenging. Abnormalities have been found in resting-state networks of mTLE patients. It is unclear if non-directed/directed connectivity between resting-state networks and mesial temporal lobe structures can aid in lateralization of mTLE patients. Also, it is unknown if directional hippocampal connectivity using fMRI resembles directional connections using stereo-electroencephalography (SEEG).

Methods: For 52 mTLE patients (15 left mTLE) and 52 matched controls, we acquired 20 minutes of resting-state fMRI. Using non-directed Pearson correlation, receiver-operating characteristic (ROC) curves, and network-based statistic (NBS) we compared ability to distinguish patients with left mTLE (LmTLE) and right mTLE (RmTLE) using mesial structure and resting-state network connectivity. We acquired two minutes of resting-state SEEG in 17 mTLE patients and calculated hippocampal vs extrahippocampal inward partial directed coherence (PDC) strength, which we then compared to directed dynamic causal modeling results calculated with fMRI.

Results: RmTLE patients had lower functional connectivity between right hippocampus and default mode network (DMN) compared to LmTLE patients and controls ($p<0.001$, corrected, ANOVA), which was not seen between hippocampus and other resting-state networks. Right hippocampal connectivity with DMN demonstrated an area under the ROC curve (AUC) of 0.85 distinguishing between LmTLE and RmTLE patients while AUCs using other networks were below 0.58. In DMN, LmTLE patient right hippocampal connectivity with medial orbitofrontal, inferior parietal, and precuneus regions was higher than RmTLE patients ($p<0.01$, $p<0.001$, $p<0.01$, corrected, ANOVA), which was reflected in NBS analysis. With dynamic causal modeling, selected models of fMRI revealed cross-hemispheric connectivity to hippocampi/amygdalae was predominately inward towards epileptogenic side. This resting-state fMRI finding resembled directed resting-state SEEG finding. Specifically, there was higher inward PDC strength in epileptogenic hippocampi versus other sampled regions in RmTLE and LmTLE patients ($p<0.01$, $p<0.05$, t-tests, corrected).

Discussion: Resting-state fMRI and SEEG studies of connectivity with resting-state networks in mTLE patients demonstrated differences between LmTLE and RmTLE patients, specifically with DMN. Furthermore, we also noted similarities between our fMRI and SEEG analyses. These inward connectivity patterns using both modalities were altered at epileptogenic hippocampi, warranting further comparison of directional connectivity between fMRI and SEEG, which could aid in employing resting-state fMRI as a noninvasive methodology to guide neuromodulation or resection targets preoperatively.

References, if any: Cataldi, et al. Resting state networks in temporal lobe epilepsy. Epilepsia. 2013.

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Epilepsy, fMRI, SEEG