Multimodal quantitative imaging detects functional but not structural abnormalities in idiopathic generalized epilepsy

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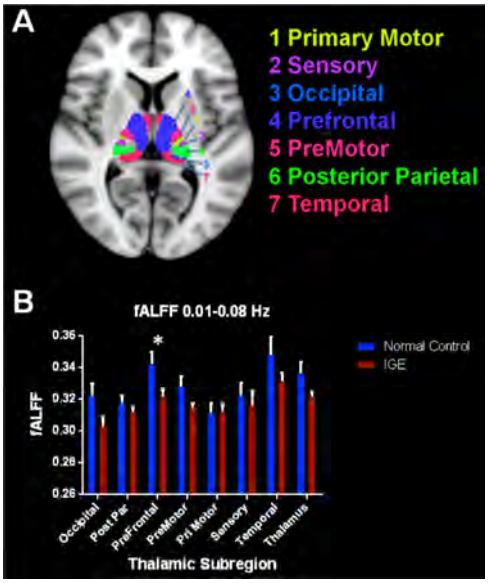
Target Audience: This study employs functional and anatomic analysis of MRI scans to detect focal and network abnormalities in Idiopathic Generalized Epilepsy (IGE). Recent developments in MRI techniques have the potential for clinical utility but such tools are underutilized in the clinical setting. Given the advances in MRI image acquisition and analysis, the study presented here is aimed at clinicians and clinical researchers to highlight how magnetic resonance capabilities can be used to study both focal and network changes in IGE and how these abnormalities can be described using morphometric, diffusion and functional metrics.

Purpose: Magnetic resonance imaging (MRI) techniques have been used to quantitatively assess focal and network abnormalities. Idiopathic generalized epilepsy (IGE) is characterized by bilateral synchronous spike-wave discharges on electroencephalography (EEG) but normal clinical MRI. Dysfunctions involving the neocortex, particularly the prefrontal cortex, and thalamus likely contribute to seizure activity. The aim of this study is to characterize focal brain abnormalities in people with IGE, a disease of unknown etiology.

Methods: Data were collected from 27 patients and 27 age- and sex-matched controls who underwent T1-weighted, resting state and diffusion-weighted imaging scans. To identify possible morphometric and functional differences in the brains of IGE patients and normal controls, we employed measures of thalamic volumes, cortical thickness, gray-white blurring, fractional anisotropy (FA) measures from diffusion tensor imaging (DTI) and fractional amplitude of low frequency fluctuations (fALFF) in thalamic subregions from resting state functional MRI.



Results: Our study shows similar thalamic volumes, cortical thickness and gray-white contrast between patients with IGE and control subjects. There are no differences in FA values on DTI in tracts connecting the thalamus and prefrontal cortex between study groups. Functional analysis revealed decreased fALFF in the prefrontal cortex (PFC) subregion of the thalamus in patients with IGE. For each metric, minimal detectable differences was calculated to estimate the minimum effect size difference between IGE subjects and controls that can be detected using our study design.

Discussion: Our structural and functional studies of thalamic-prefrontal network integrity in IGE patients identified only functional differences. Anatomic integrity was maintained in both thalamic size and cortical measures including thickness and GWC. Axon tracts between these areas as determined by DTI were not compromised in the patient group, suggesting that these structural connections are intact in IGE. While cortical and thalamic structures in IGE are morphometrically normal, abnormal rest function (i.e., decreased fALFF of the BOLD signal) was detected in the thalamic subregion that is structurally connected with the prefrontal cortex.

Conclusion:

This study employs functional and anatomic analysis of MRI scans to detect focal and network abnormalities in IGE. These advances in MRI analysis techniques provide important information about underlying pathology in epilepsy.