Magnetoencephalography detection of high-frequency oscillations in the developing brain

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Rationale: Evidence from invasive intracranial recordings suggests that the matured brain generates physiological and pathological high-frequency signals (HFOs). HFOs are potential new biomarkers for the study of brain function. The present study was designed to detect HFOs in the *developing* brain using novel noninvasive magnetoencephalography (MEG) methods.
Methods: Twenty healthy children and ten with epilepsy were studied with high-sampling rate MEG. Functional (physiological) HFOs in were evoked with electrical stimulation of index fingers. Epileptic (pathological) HFOs were recorded at resting state. To determine if HFOs were true neural activation, we analyzed MEG data using time-frequency based beamforming and accumulated source imaging.
Results: Healthy children showed HFOs (>1000 Hz) in the somatosensory cortex with a weaker amplitude, and an earlier latency than low-frequency brain signals. Magnetic source imaging revealed that HFOs were localized to the somatosensory cortex and thalamus. HFOs have also been identified in subjects with epilepsy. We found focal increases of neuromagnetic epileptic activity in 1-20 Hz (in 5/10 patients), in 20-500 Hz (10/10), in 500-1000 Hz (9/10), and in 1000-2000 Hz (8/10).
Discussion: Results show that the developing brain generates stimulation-induced and endogenous (pathological) HFOs, consistent with reports of adult HFOs. HFOs were detected with noninvasive MEG, which may be superior for use with child/clinical populations. While children undergo developmental changes between 6 and 17 years old, there are no changes in HFOs during this time. These findings open a new window for the study of developing brain function and provide novel insights into cerebral mechanisms of pediatric epilepsy.