Abstract

OBJECTIVE
To identify the predominant ictal onset frequencies with wide spectrum EEG frequency analysis.

METHODS
Fourteen patients with medically refractory partial epilepsy undergoing intracranial macroelectrode monitoring (8 depth electrodes, 6 subdural grids) were analyzed. Digital EEG data was sampled at 2 kHz at various intervals. Multiband frequency and power analysis were performed to characterize the predominating frequency during the interictal, pre-ictal, ictal, and postictal periods.

RESULTS
Fifty-one seizures—19 seizures collected from subdural grid and 32 from depth electrodes—were analyzed. Power spectrogram of frequency band between 0 – 100 Hz demonstrated a significant increase of 10 – 30 Hz frequencies preceding the increase of 30 – 100 Hz frequencies by 3 seconds before propagation in 38 seizures from 10 patients. In each case, the ictal onset was localized to one to two contacts. Focal surgical resections were performed in the areas correlated to the synchronization of these alpha-beta frequencies and HFO prior to and during the patients' clinical seizures. These 10 patients have seizure-free outcomes confirming the localization. In contrast, the alpha-beta frequencies synchronization was not seen in four patients (13 seizures) who did not become seizure-free post-operatively.

CONCLUSION
Previous studies of HFO from intracranial EEG recordings consistently show the frequencies at ictal onset above gamma range. However, most of these studies utilize microelectrodes and/or single neuron recording techniques. In our study, HFO were preceded by lower frequency activity, and the presence of the lower frequencies synchronization correlated with post-operative seizure freedom. HFO may not be the first ictal manifestation in some cases and lower frequency ictal frequencies should not be overlooked. Larger studies are underway.

5 Recent Publications

1. Rutishauser U, Ye S, Koroma M, Tudusciuc O, Ross IB, Chung JM, Mamelak AN. Representation of Retrieval Confidence by Single Neurons in the Human Medial Temporal Lobe. Nature Neuroscience. 2015;18(7):1041-50.
2. Chung JM, Meador KJ, Eisenschenk S, Ghacibeh G, Vergara DT, Eliashiv DS, Roper SN. The Utility of Invasive Ictal EEG Recordings in the Pre-Surgical Evaluation of Patients with Medically Refractory Temporal Lobe Epilepsy and Normal MRI. International Journal of Epilepsy. 2015;2(2):66-71.
3. Wang S, Yu R, Tyszka JM, Zhen S, Kovach C, Sun S, Huan Y, Hurlemann R, Ross I.B, Chung JM, Mamelank AN, Adolphs R, Rutishauser, U. The human amygdala parametrically encodes the intensity of specific facial emotions and their categorical ambiguity. Nature Communications. 2017 Apr 21;8:14821.
4. Kaminski J, Sullivan S, Chung JM, Ross IB, Mamelak AN, Rutishauser, U. Persistently active neurons in human medial frontal and medial temporal lobe support working memory. Nature Neuroscience. 2017 Apr;20(4):590-601.
5. Reed CM, Birch K, Kaminski J, Sullivan S, Chung JM, Mamelak AN, Rutishauser U. Automatic detection of periods of slow wave sleep based on intracranial depth electrode recordings. J Neuroscience Methods. 2017 Apr 15;282:1-8.

Biography

Dr. Jeffrey M. Chung received his Doctor in Medicine from Northwestern University Medical School. He is currently the Director of Epilepsy and Neurophysiology Programs at Cedars-Sinai Medical Center and an Associate Clinical Professor of Neurology at David Geffen School of Medicine at UCLA. In his clinical practice, Dr. Chung focuses on the medical and surgical treatments of patients with epilepsy. He has presented at multiple national and international conferences on the localization of the epileptogenic zone with neuronal signal processing analysis and on the prediction of surgical decisions and outcomes with multi-modal probabilistic mapping techniques. His awards include Falks Medical Scholar, CARE Outstanding Patient Care Award, and the Clinical Research Fellowship Training Award from the Epilepsy Foundation.

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