UNIVERSITY of HOUSTON | ENGINEERING

Department of Biomedical Engineering

Ph.D. Dissertation Defense

TITLE:
INVESTIGATION OF HIGH FREQUENCY OSCILLATIONS IN EPILEPSY USING COMPUTATIONAL INTELLIGENCE

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Friday, August 4, 2017
10:00 am – 12:30 pm
Cullen - Room 113

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ABSTRACT:

Epilepsy is effecting over 1% of the population worldwide, wherein 1/3 of the patients remain refractory to medication. Successful surgical treatment for patients with intractable epilepsy depends critically on the accurate delineation of the seizure onset zone (SOZ). High frequency oscillations (HFOs, 80 - 500 Hz) are proposed as putative biomarkers in epilepsy with their potentials of identifying the SOZ, either by augmenting or replacing the current preoperative evaluation modality which requires detained visual examination of long-term intracranial EEG recordings. The clinical utility of HFOs has been hampered due to the challenges associated with the quantitative identification of HFOs in massive-volume iEEG datasets. The lack of established criteria for distinguishing pathological HFOs from physiological oscillations also adds to the complexity of the problem.

This dissertation aims at the computational analysis of HFOs with specific concerns over its practical application for the localization and prediction of SOZ. We proposed novel algorithms and tools for the auto-detection of HFO in prolonged clinical data based on advanced signal processing and unsupervised machine learning techniques, and investigated the correlation of possible HFO clusters and clinician-determined SOZ in different states. The algorithm achieved significant improvement compared to existing SOZ approximation techniques, indicating that unsupervised clustering methods exploring the time-frequency content of HFOs in the available full-band can efficiently be used to localize the epileptogenic zone in clinical practice. We further investigated the spatial and temporal dynamics of HFO in long-term iEEG recordings, verified the spatial correlation of HFO and SOZ, and assessed the feasibility using automatically detected HFOs to identify SOZ in challenging cases where the ictal pattern was unclear.

Finally, for the first time we introduced SOZ-specific HFO waveform patterns which are barely observed in the functional cortex introducing physiological HFOs.

The outcomes of this work add to our understanding of the electrophysiological basis of HFOs as well as the epileptogenic networks, and provide new possibilities for the interpretation of HFOs that can be efficiently applied to distinguish SOZ from eloquent cortical areas, which is a critical step towards the translation of HFOs to valid clinical biomarkers.