Evolving into Epilepsy: Multiscale Electrophysiological Analysis and Imaging in an Animal Model

By

Dr. Justin C. Sanchez
Assistant Professor, Department of Pediatrics, Division of Neurology
University of Florida

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Abstract:
Epilepsy research for the design of seizure detection/prediction neuroprosthetics has been faced with the search for electrophysiologic control parameters that can be used to infer the epileptic state of the animal and be leveraged at a later time to deliver neurotherapeutic feedback. The analysis presented here uses multi-microelectrode array technology to provide an electrophysiologic quantification of a hippocampal neural ensemble during the latent period of epileptogenesis. Through the use of signal processing system identification methodologies, we were able to assess the spatial and temporal interrelations of ensembles of hippocampal neurons and relate them to the evolution of the epileptic condition. High-field magnetic resonance (MR) imaging was used to determine the location of electrode placement and to evaluate hippocampal pyramidal cell structural damage. Long term single unit activity analysis suggests that hippocampal neurons in both CA1-2 and dentate regions increase the number of occurrences and duration of their bursting activity after injury to the contra-lateral hippocampus. The trends inferred from both single neuron and ensemble analysis suggests that the evolution into epilepsy is not abrupt but modulates gradually from the time of injury.