Epileptic seizure in tuberous sclerosis complex

Recent evidence favors a network concept in tuberous sclerosis (TSC) with seizure generation and propagation related to changes in global and regional connectivity between multiple, anatomically distant tubers. Direct exploration of network dynamics in TSC has been made possible through intracranial sampling with stereoelectroencephalography (sEEG). The objective of this study is to define epileptic networks in TSC using quantitative analysis of sEEG recordings. We also discuss the impact of the definition of these epileptic networks on surgical decision-making.

Methods: Intracranial sEEG recordings were obtained from four pediatric patients who presented with medically refractory epilepsy secondary to TSC and subjected to quantitative signal analysis methods. Cortical connectivity was quantified by calculating pairwise coherence between all contacts and constructing an association matrix. The global coherence, defined as the ratio of the largest eigenvalue to the sum of all the eigenvalues, was calculated for each frequency band (delta, theta, alpha, beta, gamma). Spatial distribution of the connectivity was identified by plotting the leading principal component (product of the largest eigenvalue and its corresponding eigenvector).

Results: Four pediatric subjects with TSC underwent invasive intracranial monitoring with sEEG, comprising 31 depth electrodes and 250 contacts, for localization of the epileptogenic focus and guidance of subsequent surgical intervention. Quantitative connectivity analysis revealed a change in global coherence during the ictal period in the beta/low gamma (14-30 Hz) and high gamma (31-80 Hz) bands. Our results corroborate findings from existing literature, which implicate higher frequencies as a driver of synchrony and desynchrony.

Conclusions: Coordinated high-frequency activity in the beta/low gamma and high gamma bands among spatially distant sEEG define the ictal period in TSC. This time-dependent change in global coherence demonstrates evidence for intra-tuberal and inter-tuberal connectivity in TSC. This observation has surgical implications. It suggests that targeting multiple tubers has a higher chance of seizure control as there is a higher chance of disrupting the epileptic network. The use of laser interstitial thermal therapy (LITT) allowed us to target multiple disparately located tubers in a minimally invasive manner with good seizure control outcomes [1)].

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Alexander H, Govindan RB, Anwar T, Chirumamilla VC, Fayed I, Keating RF, Gaillard WD, Oluigbo CO. Global and intertuberal epileptic networks in tuberous sclerosis based on stereoelectroencephalographic (sEEG) findings: a quantitative EEG analysis in pediatric subjects and surgical implications. Childs Nerv Syst. 2021 Aug 29. doi: 10.1007/s00381-021-05342-1. Epub ahead of print. PMID: 34455445.