Epileptogenic network

Epileptogenic networks are defined by the brain regions involved in the production and propagation of epileptic activities.

In the context of epilepsy surgery, the determination of cerebral regions producing seizures (i.e., the "epileptogenic zone") is a crucial objective. In contrast with a traditional focal vision of focal drug-resistant epilepsies, the concept of epileptogenic networks has been progressively introduced as a model better able to describe the complexity of seizure dynamics and realistically describe the distribution of epileptogenic anomalies in the brain. The concept of epileptogenic networks is historically linked to the development of the stereoelectroencephalography (SEEG) method and subsequent introduction of means of quantifying the recorded signals. Seizures, and preictal and interictal discharges produce clear patterns on SEEG. These patterns can be analyzed utilizing signal analysis methods that quantify high-frequency oscillations or changes in functional connectivity. Dramatic changes in SEEG brain connectivity can be described during seizure genesis and propagation within cortical and subcortical regions, associated with the production of different patterns of seizure semiology. The interictal state is characterized by networks generating abnormal activities (interictal spikes) and also by modified functional properties. The introduction of novel approaches to large-scale modeling of these networks offers new methods in the goal of better predicting the effects of epilepsy surgery. The epileptogenic network concept is a key factor in identifying the anatomic distribution of the epileptogenic process, which is particularly important in the context of epilepsy surgery [1)].

The hippocampus and amygdala are two crucial structures of the mesial temporal lobe and play important roles in the epileptogenic network of MTLE. This study aimed to explore the effective connectivity among the hippocampus, amygdala, and temporal neocortex and to determine whether differences in effective connectivity exist between MTLE patients and non-MTLE patients.

Methods: This study recruited 20 patients from a large cohort of drug-resistant epilepsy patients, of whom 14 were MTLE patients. Single-pulse Electrostimulation (SPES) was performed to acquire cortico-cortical evoked potentials (CCEPs). The root mean square (RMS) was used as the metric of the magnitude of CCEP to represent the effective connectivity. We then conducted paired and independent sample t-tests to assess the directionality of the effective connectivity.

Results: In both MTLE patients and non-MTLE patients, the directional connectivity from the amygdala to the hippocampus was stronger than that from the hippocampus to the amygdala ($P < 0.01$); the outward connectivity from the amygdala to the cortex was stronger than the inward connectivity from the cortex to the amygdala ($P < 0.01$); the amygdala had stronger connectivity to the neocortex than the hippocampus ($P < 0.01$). In MTLE patients, the neocortex had stronger connectivity to the hippocampus than to the amygdala ($P < 0.01$). No significant differences in directional connectivity were noted between the two groups.

Conclusions: A unique effective connectivity pattern among the hippocampus, amygdala, and temporal neocortex was identified through CCEPs analysis. This study may aid in our understanding of physiological and pathological networks in the brain and inspire neurostimulation protocols for neurological and psychiatric disorders [2)].

1)

https://onlinelibrary.wiley.com/doi/full/10.1111/epi.13791

[2)]

Guo Z, Zhao B, Hu W, Zhang C, Wang X, Wang Y, Liu C, Mo J, Sang L, Ma Y, Shao X, Zhang J, Zhang K. Effective connectivity among the hippocampus, amygdala, and temporal neocortex in epilepsy patients: A cortico-cortical evoked potential study. Epilepsy Behav. 2021 Jan 8;115:107661. doi: 10.1016/j.yebeh.2020.107661. Epub ahead of print. PMID: 33434884.