

Epileptogenic focus localization through functional connectivity analysis of the intracranial EEG.

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Epilepsy is a chronic neurological disorder characterized by recurrent seizures. Around 1% of the worldwide population has epilepsy. Approximately 30% of the patients cannot be adequately cured with anti-epileptic drugs. These patients have, so called, refractory epilepsy. Alternatively these patients can be rendered seizure free by removing the epileptogenic focus, i.e. the brain region responsible for causing the epileptic seizures. This implies the need for accurate localization of the epileptogenic focus. During the pre-surgical evaluation the neurologist identifies the epileptogenic focus through visual inspection of the intracranial electroencephalographic (IEEG) signals.

An algorithm was developed to localize the epileptogenic focus more accurately based on connectivity analysis of the IEEG signals. Causality analysis was performed on the ictal IEEG in 5 patients. A time-variant multivariate autoregressive (TVAR) model was estimated out of the IEEG signals by using Kalman filtering. The full-frequency Adaptive Directed Transfer Function was calculated out of these TVAR-coefficients [1]. The out-degree of the IEEG channels was visualized over time and the epileptogenic focus was identified. The IEEG channel with the maximal out-degree is pinpointed as the driver behind the seizures.

In the 5 patients we found a high correlation between the estimated epileptogenic focus and the resected brain area. The proposed method is capable to localize the epileptogenic focus through the analysis of IEEG signals without prior knowledge of electrode positions in the 5 investigated patients. The results are concordant with post-operative results. This implies that the time-variant connectivity analysis of seizure onsets may add valuable information during the pre-surgical evaluation of a patient.

[1] van Mierlo P et al. , Accurate epileptogenic focus localization through time-variant functional connectivity analysis of intracranial electroencephalographic signals. *Neuroimage*. 2011 Jun 1;56(3):1122-33.