Previous Abstract

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Static and Dynamic Granger Causality in Epileptic spike propagation

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Objective: Magnetoencephalography (MEG) and electroencephalography (EEG) have beer localize and characterize the epileptogenic areas. Previously, we reported the combination o spatiotemporal dSPM (dynamic Statistical Parametric Mapping), and spectral spatiotempora of MEG to lateralize of the primary epileptic area in a case with intractable frontal epilepsy bilateral independent spikes on EEG [1, 2]. The dSPMs showed that the right frontal activity occurs prior to the left frontal activity. Here, we further use the Granger causality [3] to eva quantitative causal interaction statically and dynamically from the two frontal loci of epilep genesis.

Methods: The patient was an 11 year old, right-handed girl presented with complex partial (CPS) refractory to antiepileptic medications. 306-channel whole head MEG with simultane channel EEG (Elekta Neuromag Ltd., Helsinki, Finland) was sampled at 600 Hz. MEG/EEG coregistered to a 3T MRI (Siemens Medical Solutions, Erlangen, Germany). The imaging se was MPRAGE sequence. Spatiotemporal and spectral spatiotemporal dSPM analyses were in [3].

The Granger causality was calculated based on the multivariate autoregressive (MAR) analy the time series [4] based on the left and right frontal loci revealed by dSPM analyses. The or the MAR analysis was determined by the Schwarz's Bayesian Criterion [5]. Static Granger (sGC) was calculated from all pairs of the dipoles in the left and right frontal ROIs within th interval of 200 ms before and after spike peak. Dynamic Granger Causality (dGC) was calcu with the 120 ms moving temporal window in the 400 ms interval with the dipoles time serie described above.

Results & Discussion: Figure 1 shows the dSPM results of left and right frontal lobe epilep activity. Significant right frontal lobe activity was observed at 21 ms before the peak of the frontal epileptic spike. Table 1 lists the sGC between left and right frontal loci. SGC indicat causal interaction from right frontal to left frontal lobe in the epileptic event. Note that at approximately 20 ms before the peak of left frontal spike, right frontal ROI started to demor significant causal influence on the left frontal ROI (Figure 2). Such causal influence lasted u ms after left frontal spike peak

Conclusions: In this study, we demonstrated Granger Causality to evaluate the causal influe between epilepsy loci both statically and dynamically. With further validation efforts, inclu surgical outcomes and simulations, this method may be applied to detect the primary epilep genesis locus and to maximize the effectiveness of epilepsy surgery.

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Table 1

	Avg.	Std.
Left frontal to right frontal	0.15	0.06
Right frontal to left frontal	0.03	0.02

The mean (avg.) and standard deviation (std.) of the static Granger Causality between le right frontal lobes