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Identifying the Origin of the Source in Multi-focal Epilepsy Patients

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Background:

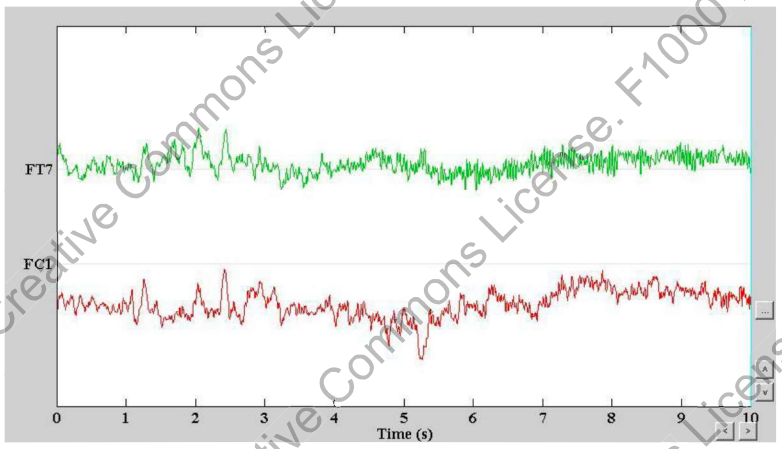
The aim of this study was first to identify the first two neuronal sources in the brain which shows the highest dipole strength caused by the multi-focal epileptic activity using the Minimum-norm (MN) inverse solution technique on a realistic head model.

The second aim is to study the dynamics of these two source signals so as to identify which part of the brain is activated first and which part follows using the time-frequency analysis.

Data:

In this study, the EEG data from 6 patients with multi-focal epilepsy were recorded for 10 seconds to record the beginning of the seizure, 5 seconds before and 5 seconds after seizure onset with a sampling frequency of 200 Hz.

40-60 electrodes were used depending on the patient according to the 10-10 international system to record the seizure.



Methods

Forward Problem

To achieve an accurate approximate of the brain realistically shaped head model is constructed using the boundary-element method (BEM) by a description of the individual electrode locations and magnetic resonance imaging (MRI) from each patient.

The typical head model used in this analysis assumes that the head consists of a set of meshes, triangulated surfaces in 3D-space, typically representing the brain, skull and scalp.

Inverse Solution

The resulting forward model is then used to solve the inverse problem. Minimum-norm is used to estimate the current sources in the brain that best fit the measured data.

The source analysis was performed on the time instant where the highest amplitude of the mean global field power (MGFP) occurs from the whole seizure EEG segment.

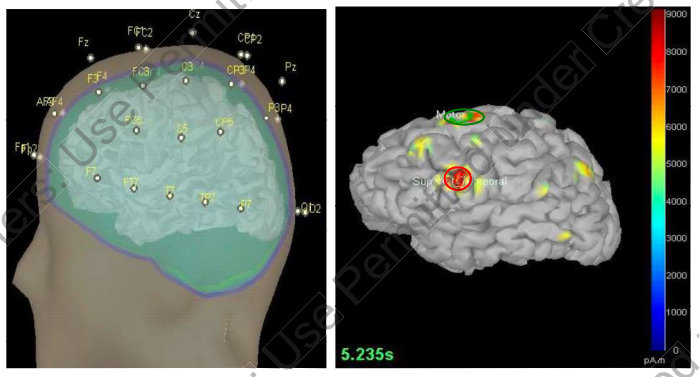
Time-Frequency (TF) Analysis

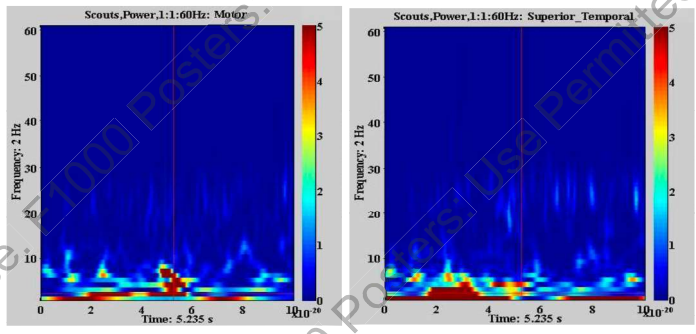
Time-frequency representation was performed on the extracted source signals using complex morlet wavelets to visualize the power dynamics of the sources over the frequency range of 1-60 Hz and time duration of 10 seconds.

To better visualize the power dynamics of the two sources for one parameter (time or frequency) when the other parameter is fixed, the power spectrum and time series was generated from the TF decomposition.

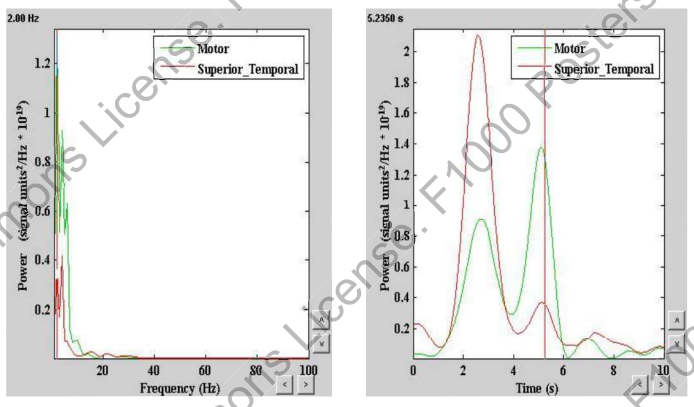
Results:

Two regions of activation that are presumably the source of the seizure were obtained from the source analysis for all the patients. These activation regions represent the epileptogenic areas for the multi-focal epileptic patients.





The time series generated from the TF decomposition at a specific frequency showed clearly the time dynamics of the two extracted source signals.



Conclusion:

1) The source analysis revealed the first two neuronal networks, which showed the highest dipolar strength, in each patient.

2) The power dynamics over the whole time duration and frequency gives valuable information in identifying the region of the brain which is activated first for each patient before the surgical procedure.