

Methodological and clinical aspects of ictal MEG

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Epilepsy is relatively frequent disease affecting about 0.7% of general population. About 25% of epilepsy patients are resistant to pharmacological treatment. In this situation epilepsy surgery may be an option. The most efficient form of epilepsy surgery is epileptogenic zone (EZ) resection. Ictal onset zone (IOZ) is an essential part of EZ and therefore the evaluation of location and configuration of IOZ is one of the most important goals of pre-surgery workup. The main non-invasive method which provides the information about IOZ is video-EEG, another well known non-invasive technique is ictal SPECT.

MEG can localize brain activity with high accuracy. In epilepsy the role of MEG in localizing interictal spikes has been broadly studied and documented.

Can MEG be accurate and practical in localization ictal onset sources? Ictal MEG is a challenging procedure by several reasons:

- 1) Seizure should occur during MEG measurement.
- 2) Head movement should be recorded and compensated.
- 3) Movement artifact should be suppressed.
- 4) Ictal onset signal has often poor signal-to-noise ratio(SNR).

Recording seizures during MEG acquisition can be achieved by following:

- 1) appropriate planning of MEG recording according to expected seizure occurrence;
- 2) long MEG acquisition (sequence of about two hours sessions with intervals);
- 3) sleep deprivation;
- 4) antiepileptic drug reduction;
- 5) specific provocations (e.g. photic stimulation).

Head position can be continuously monitored using head position indicator (HPI) coils which produce sinusoidal magnetic signal with frequencies above the frequency of interest. The compensation of head position can be done using signal space separation (SSS) based movement compensation.

Movement artifact suppression demands application of spatio-temporal signal separation (tSSS). This method is also important in suppressing of noise increment which can occur due to head movement compensation. Fine tuning of tSSS correlation limit can be important to avoid misinterpretation of residual interference.

The source modeling of MEG ictal onset zone is not always simple because of low SNR and fast dynamics of this signal. Nevertheless, multiple equivalent current dipoles model is often sufficient. Another approach is evaluation of frequency spectrum dynamics.

Video-MEG (VMEG) assists to analyze the ictal MEG signal and to relate this signal to video-EEG and to video-intracranial EEG monitoring.

The clinical role of ictal MEG is addition sensitivity to interictal MEG source clusters on the lobar surface level. Ictal MEG is very sensitive and specific on the lobe level.

Ictal MEG is challenging but promising tool in epilepsy pre-surgery workup.