Continuity of surface negativity form fissural cortex to gyral cortex at latency of MEG spike peak

Kamran Alioglu SALAYEV, *Nobukazu NAKASATO, Mamiko ISHITOBI, *Hiroshi SHAMOTO, *Akitake KANNO, Kazuie IINUMA, Shigeru TSUCHIYA

*Department of Pediatrics, Tohoku University School of Medicine, Sendai, Japan; *Department of Neurosurgery and Tohoku Ryogo Center, Kohnan Hospital, Sendai, Japan*

Background and Objective: Equivalent current dipole (ECD) model in magnetoencephalography (MEG) is a noninvasive method that is commonly used to estimate the source of the epileptogenic activity. However, the position of ECD is influenced by many factors that limit its application. As it was summarized by Cohen and Cuffin[1], the theoretical and computer modeling studies of MEG indicated the localization errors of about 10 mm, whereas the localization error may be even more in the clinical settings. In case of spikes generated in the fissure, possible localization error of ECD model is large enough to preclude the correct identification of the epileptogenic lobe. It is known from EEG that the gyral cortex is gross negative at the peak latency of EEG spike. In this study, we investigated a hypothesis that the surface negativity of the fissural cortex at the latency of MEG spike peak corresponds to the surface negativity of the gyral cortex. If our hypothesis is correct, the orientation of MEG ECD has clues for the identification of the epileptogenic lobe.

Method: We retrospectively analyzed MEG spikes (n=133) in 8 patients with localization related epilepsy. We identified the epileptogenic lobe on the basis of seizure semiology, EEG seizure onset, electrocorticography recording, and structural lesion detected by MR imaging. Each patient had one cluster of MEG spike dipoles localized on the sulcus adjacent to the epileptogenic lobe: interhemispheric fissure (4 patients) or central sulcus (4 patients). All MEG spike peaks showed dipoles with the positive/negative pole oriented toward the epileptogenic/normal lobe. We used MEG spike peaks as a trigger for MEG and EEG averaging on BESA software (BESA 5.0; MEGIS Software GmbH, Munich, Germany). Isopotential EEG map patterns of averaged EEG spikes above the sulcus of MEG spike dipole localization were analyzed. Additionally, we localized regional source for each averaged MEG spike, and then analyzed the radial current direction in EEG at the same location.

Results: Averaged MEG spike peaks always corresponded to broad surface negativity in averaged EEG spikes. The negative pole of radial currents in EEG was always oriented outward.

Discussion and Conclusion: In the present study, orientation of ECDs of all single MEG spikes suggested surface negativity of the fissural cortex at the epileptogenic side. Similar MEG pattern remained after an averaging of MEG spikes: the positive/negative pole of ECD oriented toward the epileptogenic/normal lobe. The broad surface negativity map pattern in averaged EEG spikes can be explained by continuous surface negativity from fissural to gyral cortex. The direction of the radial current in averaged EEG spikes also suggested surface negativity of the gyral cortex; thus gives further support for the continuity of the surface negativity. Our findings support the hypothesis that spikes associated with benign childhood epilepsy with centrotemporal spikes are generated by surface negative activity in the precentral cortex: radial current in the dorsolateral gyral cortex, and tangential current in the sulcal wall of the frontal side facing the central, sylvian, and interhemispheric fissures.[2]

References

1. Cohen D, Cuffin BN. EEG versus MEG localization accuracy: theory and experiment. *Brain Topogr* 1991; 4: 95-103.
2. Ishitobi M, Nakasato N, Yamamoto K, Iinuma K. Opercular to interhemispheric source distribution of benign rolandic spikes of childhood. *Neuroimage* 2005; 25: 417-23.