Dipole Source Analysis for Readiness Potential and Field Using Simultaneously Measured EEG and MEG Signals


Abstract—Various source localization techniques have indicated the generators of each identifiable component of movement-related cortical potentials, since the discovery of the surface negative potential prior to self-paced movement by Kornhuber and Decke. Readiness potentials and fields preceding self-paced finger movements were recorded simultaneously using multichannel electroencephalography (EEG) and magnetoencephalography (MEG) from five healthy subjects. The cortical areas involved in this paradigm are the supplementary motor area (SMA) (bilateral), pre-SMA (bilateral), and contralateral motor area of the moving finger. This hypothesis is tested in this paper using the dipole source analysis independently for only EEG, only MEG, and both combined. To localize the sources, the forward problem is first solved by using the boundary-element method for realistic head models and by using a locally-fitted-sphere approach for spherical head models consisting of a set of connected volumes, typically representing the scalp, skull, and brain. In the source reconstruction it is to be expected that EEG predominantly localizes radially oriented sources while MEG localizes tangential sources at the desired region of the cortex. The effect of MEG on EEG is also observed when analyzing both combined data. When comparing the two head models, the spherical and the realistic head models showed similar results. The significant points for this study are comparing the source analysis between the two modalities (EEG and MEG) so as to assure that EEG is sensitive to mostly radially orientated sources while MEG is only sensitive to only tangential sources, and comparing the spherical and individual head models.