Towards the Cardiac Equivalent Source Models in ECG and MCG Problems: A Simulation Study

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The cardiac equivalent source model is very crucial in the electrocardiogram (ECG) and magnetocardiography (MCG) problems. Many source models have been proposed and applied to explain and calculate the cardiac electromagnetic signals, in which the dipole, equivalent double layer (EDL) and epicardial potential (EP) models are commonly used. However, the performance of three source models have not been explored and compared into a unified framework. In this study, we presents a thoroughly investigation of these three models in terms of the ECG/MCG forward problem. Based a virtual heart model with electric excitation, the cardiac electromagnetic field is cal-culated with boundary element method (BEM). The numerical performance and the properties of the three source models are studied detailed for electric and magnetic fields. For the three source models, three different resolutions of dipole and two of EP and EDL models are studied. The dipole and EDL source models are directly calculated from the heart model, while the EP source is from the dipole or EDL models. Besides, the effect of the volume conductor model is also studied. The simulation results demonstrated that the resolution of the source models shouldn't be too small, otherwise some in-formation about the cardiac activities will be lost as shown in the single di-pole model situation. The effect of the resolution on the MCG is larger than that on BSP. The higher resolutions of the source, the larger effect of the vol-ume conductor happened for each source. While for the EDL source, the lung has little effect on the MCG. The EDL source can generate the similar per-formance compared to the dipole source, while the largest difference hap-pened at the time when the ventricle start or finish the activation. The pre-sented study suggests that the EDL source is a good choice as source model for ECG/MCG problem.