Moving Equivalent Dipoles Derived from the Body Surface Potential Map by Solving the Inverse Problem

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Hypothesis/Objective: The aim of this study is to determine instantaneous 3-D locations of moving equivalent dipoles (ED) corresponding to singular value decomposition (SVD) components obtained from body surface potential map (BSMP) of the CINC/Physionet Challenge 2007 database. Mehtod: The proposed method is based on the relationship between SVD components and ED parameters derived for this purpose. Here we use a dipole model in a bounded spherical homogenous conductor (Geselowitz and Ishiwatari 1965), with the dipole moment and dipole spatial parameters separated. Dipole parameters are obtained in two steps: first (forward problem formulation), the dipole moment parameters are calculated from each SVD component for a dipole with the known location,, and second (inverse problem formulation), dipole location is varied until reaching the optimal one at the minimum in the selected objective function. Our method was successfully tested using Gabor Nelson method. In calculations, we used BMSP of 71 anterior leads (of the Dalhouise 120 torso leads), assuming a standard thorax dimensions (homogenous and isotropic thorax conductance distribution) approaching the spherical surface in the applied region. All BMSPs were first divided into short intervals (4 ms in the QRS, and 20 ms in the T wave region). These parts of BMSP signals were then decomposed, and from 3 biggest SVD components the corresponding EDs were determined. Results: Each set of BMPS data was represented with sequential arrays of EDs, each with changing dipole moment, spatial orientation, and a 3D location, thus providing additional information for the interpretation of ECG. This representation enabled a relatively precise reconstruction of all 71 BMSP signals used: in four BMPS cases mean deviations of the reconstructed BMSP from the original one were 0.025, 0.020, and 0.0195 mV (in all SE of +-0.002mV), when EDs of the first one, two and first three SVD components, respectively, were used.