Effect Of Cardiac Motion On Body Surface Electrocardiographic Potentials: An MRI-Based Simulation Study

Wei, Qing and Liu, Feng and Appleton, Ben and Xia, Ling and Liu, Nianjun and Wilson, Stephen and Riley, Robyn and Strugnel, Wendy and Slaughter, Richard and Denman, Russel and Crozier, Stuart

Physics in Medicine and Biology (2006) 51(14):3405-3418.

doi:10.1088/0031-9155/51/14/009

Abstract

This paper describes an electrical model of cardiac ventricles incorporating real geometry and motion. The heart anatomy and its motion through the cardiac cycle are obtained from segmentations of multiple-slice MRI time sequences; the special conduction system is constructed using an automated mapping procedure from an existing static heart model. The heart model is mounted in an anatomically realistic voxel model of the human body. The cardiac electrical source and surface potentials are determined numerically using both a finite-difference scheme and a boundary-element method with the incorporation of the motion of the heart. The electrocardiograms (ECG) and body surface potential maps are calculated and compared to the static simulation in the resting heart. The simulations demonstrate that introducing motion into the cardiac model modifies the ECG signals, with the most obvious change occurring during the T-wave at peak contraction of the ventricles. Body surface potential maps differ in some local positions during the T-wave, which may be of importance to a number of cardiac models, including those incorporating inverse methods.

Keywords
body surface potential; electrocardiogram; ECG; cardiac