Experimental Validation of Image-Based Modeling of Torso Surface Potentials During Acute Myocardial Ischemia

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Introduction: Myocardial ischemia is an early clinical indicator of several underlying cardiac pathologies, including coronary artery disease, Takatsobu cardiomyopathy, and coronary artery dissection. Significant progress has been made in computing body-surface potentials from cardiac sources by solving the forward problem of electrocardiography. However, the lack of *in vivo* studies to validate such computations from ischemic sources has limited the translational potential of such models.

Methods: To resolve this need, we have developed a large-animal experimental model that includes simultaneous recordings within the myocardium, on the epicardial surface, and on the torso surface during episodes of acute, controlled ischemia. Following each experiment, magnetic resonance images were obtained of the anatomy and electrode locations to create a subject-specific model for each animal. From the electrical recordings of the heart, we identified ischemic sources and used the finite element method to solve a static bidomain equation on a geometric model to compute torso surface potentials.

Results: Across 33 individual heartbeats, the forward computed torso potentials showed only moderate agreement in both pattern and amplitude with the measured values on the torso surface. Qualitative analysis showed a more encouraging pattern of elevations and depressions shared by computed and measured torso potentials. Pearson's correlation coefficient, root mean squared error, and absolute error varied significantly by heartbeat (0.1642 ± 0.223, 0.10 ± 0.03mV, and 0.08 ± 0.03mV, respectively).

Discussion: We speculate several sources of error in our computation including noise within torso surface recordings, registration of electrode and anatomical locations, assuming a homogeneous torso conductivities, and imposing a uniform "transition zone" between ischemic and non-ischemic tissues. Further studies will focus on characterizing these sources of error and understanding how they effect the study results.

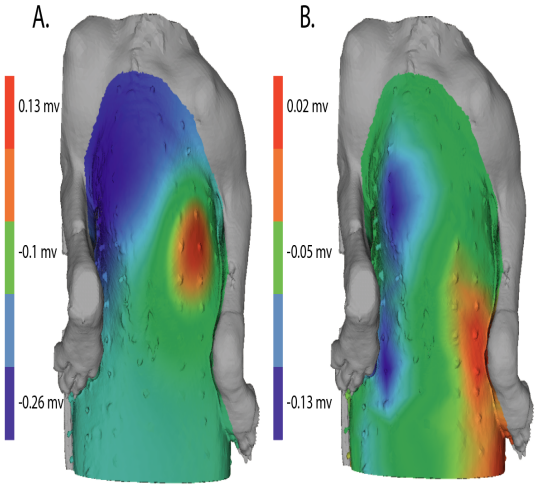

Figure 1. Image of computed and measured potentials on the torso surface A. Forward-computed ST40 potential values. B. Experimentally measured ST40 potential values.