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BEng (Electrical), Dalhousie University, 2004

SCHOOL OF BIOMEDICAL ENGINEERING

TITLE OF THESIS: Noninvasive Imaging of Epicardial Potentials for Clinical Electrophysiology

TIME/DATE: 2:00 p.m., Friday, October 9, 2009

PLACE: Room 3-H1, Sir Charles Tupper Medical Building, 5850 College Street

EXAMINING COMMITTEE:

Dr. Robert Lux, Nora Eccles Harrison Cardiovascular Research & Training Institute, University of Utah (External Examiner)

Dr. John L. Sapp, Department of Medicine, Dalhousie University (Reader)

Dr. Joshua Leon, Faculty of Engineering, Dalhousie University (Reader)

Dr. B. Milan Horacek, Department of Medicine and School of Biomedical Engineering, Dalhousie University (Co-Supervisor)

Dr. John C. Clements, Department of Mathematics and Statistics and School of Biomedical Engineering, Dalhousie University (Co-Supervisor)

Dr. Janie Astephen Wilson, School of Biomedical Engineering, Dalhousie University (Departmental Representative)

CHAIR: Dr. Tom MacRae, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

Disruptions of the regular heart rhythm, cardiac arrhythmias, constitute a major medical problem worldwide. Noninvasive diagnosis of arrhythmias is currently based on the standard electrocardiographic technique, which involves measuring heart-produced electrical potentials at 6 chest electrodes and 4 electrodes at extremities. Although the standard clinical electrocardiography, which is 100 years old, has been one of the most useful tools of modern medicine, it needs further development for some special applications. This dissertation deals with *electrocardiographic imaging* technique intended for specialized clinical electrophysiological laboratories, where patients with life-threatening cardiac arrhythmias are treated. By this technique, electrograms and electrical activation sequences on the heart's outer surface are reconstructed from body-surface electrocardiograms acquired from an array of 120 chest electrodes. For accurate patient-specific computations, geometry of the patient's chest surface and heart surface-derived by means of other imaging modalities-has to be known. The dissertation explored the capabilities and limitations of electrocardiographic imaging in two different, yet related, applications: (1) guiding radiofrequency catheter ablation performed in the clinical electrophysiology laboratory in patients suffering from scar-related ventricular tachycardia, and (2) assessment of substrate for ventricular arrhythmias in postinfarction patients.

Findings of this study indicate that electrocardiographic imaging can identify with reasonable accuracy anatomical regions to which ablation therapy should be directed to terminate the arrhythmia, and that measures derived from this noninvasive imaging technique to delineate infarct scar are in good agreement with gold-standard imaging techniques. In the diagnostic workup for catheter ablation, and during ablation itself, electrocardiographic imaging can serve as a first-step localization method that can assist invasive point-by-point electroanatomic mapping and ablation therapy.