Epicardial Isochrones and a New High-frequency ECG Isochrones Technique

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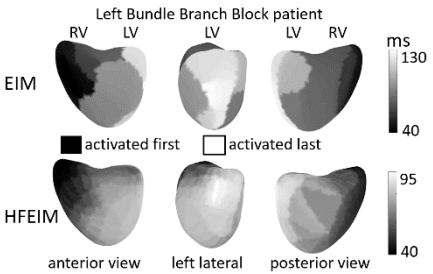
Introduction: Much progress has been made in computing epicardial potentials and epicardial isochrones maps (EIM) using inverse reconstruction from body-surface ECGs. The purpose of this study is to compare EIM with a new technique based on epicardial isochrones computation from high-frequency components projected onto the epicardium (HFEIM).

Method: We compared three subjects – normal (N), left bundle branch block (LBBB) and right bundle branch block (RBBB). Body-surface potentials were measured: 5-minute supine, 2 KHz sampling, 184 electrodes (Maastricht University, NL). These potentials were used for inverse reconstruction of EIM using patient-specific torso-heart geometry (CT, MRI). HFEIM were acquired as follows: 1. Body-surface QRS amplitude envelopes in a frequency range of 150–400 Hz were averaged with an R-wave trigger (HFQRS), 2. HFQRS were projected onto the epicardium, 3. The time delay from the onset of the QRS complex to centers of mass above the 50 percent threshold of epicardial HFQRS were computed.



Results: EIM and HFEIM were calculated for 2,100 virtual positions on the epicardium. The pattern of electrical activation based on EIM and HFEIM was similar for all three subjects. The linear Pearson correlation coefficient R between EIM and HFEIM activation times was assessed. For N-LBBB-RBBB subjects: R = 0.42, 0.82, 0.83, respectively – $p < 0.001$. The maximal HFEIM dyssynchrony was about 40 ms lower than maximal EIM dyssynchrony: maximal EIM dyssynchrony was 77, 96, 121 ms and maximal HF-EIM dyssynchrony 27, 57, 78 ms, respectively.

Conclusions: Lower HFEIM delays based on depolarization activation center of mass instead of maximal negative slope (EIM) reflected more physiologically the electrical activation distribution in the ventricles. Moreover, it uses direct projection of a single surface electrode on the epicardium, for which reason a limited 12-lead ECG setup may be used for ventricular electrical dyssynchrony computation.