Comparison of two equivalent dipole layer based inverse electrocardiography techniques for the non-invasive estimation of His-Purkinje mediated ventricular activation

Machteld J Boonstra[1], Rob W Roudijk[1], Peter Loh[1], Peter M van Dam[1]

[1]Department of Cardiology, Division Heart & Lungs, University Medical Center Utrecht, Utrecht University, Utrecht, the Netherlands

Background: Inverse electrocardiography (*i*ECG) is used to non-invasively estimate the cardiac activation sequence. This becomes increasingly difficult during His-Purkinje mediated ventricular activation when the myocardium is activated through multiple activation wavefronts. Equivalent dipole layer based *i*ECG requires an initial estimate of the ventricular activation sequence, wherein cardiac physiology can be incorporated. A physiologically realistic initial estimation should be based on a combination of waveforms initiated at His-Purkinje associated endocardial locations, instead of an iterative multi-focal search. In this study, performance of multi-focal *i*ECG and multi-wave *i*ECG was compared.

Methods: Six subject specific CT-based geometries of ventricles, lungs and thorax were created and supplemented with electrode positions. In ventricular geometries, papillary muscles and moderator band were incorporated. For each subject, His-Purkinje mediated activation with (RBBB/LBBB) and without (normal) conduction defect were simulated. Corresponding 67-lead body surface potentials (BSP) were computed and used as input for both *i*ECG techniques. Estimated activation sequences of both *i*ECG techniques were compared to simulated activation sequences. In one subject, 67-lead BSP measurement was performed during His-Purkinje mediated activation and used as input for both *i*ECG techniques. For this subject, *i*ECG estimated maps were compared to invasive mapping.

Results: Figure 1 displays an example of the estimation of normal activation. Mean inter-map correlation between simulated and estimated activation sequences for multi-focal *i*ECG vs. multi-wave *i*ECG was 59±36% vs. 86±7% for normal activation, 79±8% vs. 72±17% for RBBB activation and 41±31% vs. 62±25% for LBBB activation. In the subject with measured BSP and invasive mapping, epicardial inter-map correlation between invasive and *i*ECG maps was -4±8% for multi-focal *i*ECG and 65±1% for multi-wave *i*ECG.

Conclusion: This study shows improved performance of multi-wave *i*ECG for the estimation of His-Purkinje mediated activation sequences with and without conduction defect. Future research focusses on further validation of multi-wave *i*ECG using invasive mapping.

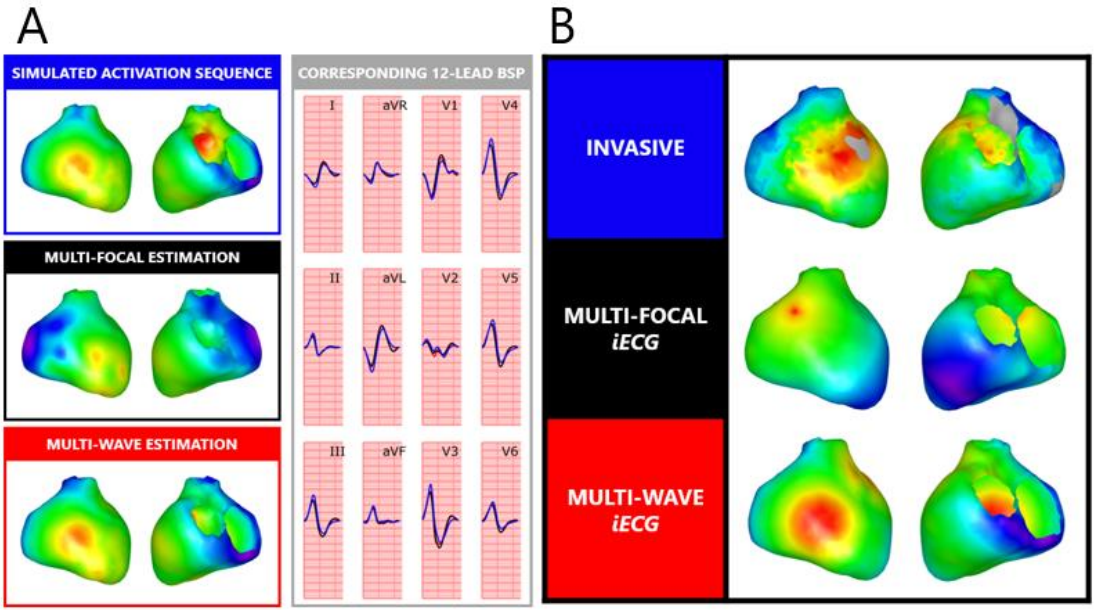

Figure 1: The estimation of the activation sequence using multi-focal iECG (black) and multi-wave iECG (red) of normal His-Purkinje mediated activation from early (red) to late (purple) activation. ***A****: Representative results obtained from the simulation study. Activation sequences and corresponding 12-lead BSP are displayed.* ***B****: Epicardial invasive map, multi-focal iECG and multi-wave iECG estimation of one subject are displayed.*