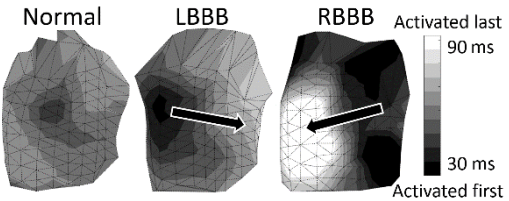
# Body-surface Mapping Using High-frequency ECG to Characterize Electrical Activation Delay

Petr Andrla, Pavel Leinveber, Uyên Châu Nguyên, Ivo Viscor, Filip Plesinger, Frits W. Prinzen, Josef Halamek, Magdalena Matejkova, Pavel Jurak

Institute of Scientific Instruments, CAS, CZ
ICRC, St. Anne's University Hospital, Brno, CZ
Department of Physiology, Maastricht University Medical Center, Maastricht, the Netherlands

Introduction: Information about ventricular electrical activation delay (VED) is important in cardiac resynchronization therapy. Standard body-surface mapping may not accurately reflect VED. The purpose of this study is to introduce VED obtained from high-frequency body-surface maps (HFBSM).

Method: Body-surface potential data was collected from two centers: Maastricht University (2 kHz sampling, 184 electrodes, three subjects) and St. Anne's University Hospital Brno (5 kHz sampling, 96 electrodes, four subjects). The amplitude envelopes of the QRS complex were computed in a frequency band of 100–400 Hz and were averaged with an R-wave trigger (HFQRS). HFBSM shows the time-varying distribution of the HFQRS throughout the whole torso surface. Activation times were defined as a delay from the beginning of the QRS complex to the center of mass above the 50 percent threshold of HFQRS, and activation maps were produced. Two different methods of VED computation were chosen: VED_MAX – maximal activation time difference from the whole surface, and VED_V1-6 – delay between lead V1 and V6. Electrical dyssynchrony was quantified as the standard deviation of activation times from all electrodes (SDAT).




Results: We studied seven patients – three normal (N), three left bundle branch block (LBBB) and one right bundle branch block (RBBB). HFBSM and activation maps demonstrated the varying dyssynchrony of electrical activation across different pathologies. Maps showed LBBB with early, rapid activation of the anterior region (right ventricle) and late activated posterior region (left ventricle), RBBB with the opposite pattern, and synchronous activation for the normal heart. For N/LBBB/RBBB, the mean values: SDAT 3.2/18.3/20.6 ms, VED_V1-6 3/54/-65 ms, VED_MAX 18/71/-83 ms and QRSd 83/141/160 ms were computed. The VED parameter differs significantly between all groups of subjects. HFBSM allows easy calculation of ventricular electrical delay directly from the torso surface.