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SLOW SEPTAL CONDUCTION IS KEY IN LBBB PATIENT-SPECIFIC MODELS

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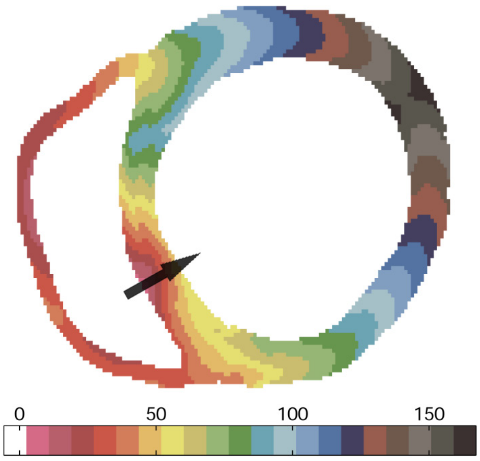
PURPOSE: Left-bundle-branch block (LBBB) is a heterogeneous ventricular electrical disorder. Patient-specific models were created to characterize myocardial electrical properties in heart failure patients with LBBB.

METHODS: The database consisted of 10 patients diagnosed with LBBB with no scars as detected by cardiac magnetic resonance imaging (CMR). The ECG criteria proposed by Strauss et al. were used for LBBB diagnosis. Realistic individual anatomical models were created from CMR images. Properties such as early activation sites, tissue conductivity, and ionic current dynamics in ventricular cells were tuned to match both clinically recorded ECG and intracardiac ventricular activation sequence. Electrical activity in the ventricles was simulated using a reaction-diffusion equation. The Ten Tusscher-Panfilov 2006 model was used to simulate cell electrophysiology. Intracardiac electrograms and 12-lead ECGs were computed by solving the bidomain equation.

SUMMARY: Left ventricular endocardial activation was completed in about 80-90 ms. In order to match the recorded electrical activation sequence and the QRS morphology, the conduction velocity needed to be increased slightly in some of the models. Most of the 10 patient-specific models presented similarities in their tuning: reduction of cell surface-to-volume ratio to mimic hypertrophy and increase conduction velocity, and reduction of potassium currents and heterogeneous distribution of their densities to match the T wave. Specific regional properties in the septum of very slow conduction, particularly in the cross-fiber direction (see example in the Figure), were essential to simulate the prolonged trans-septal delay from the right to the left ventricle in some LBBB patients.



CONCLUSION: Despite notable prolongation of trans-septal time in LBBB patients, conduction velocity in the working myocardium is not impaired in all patients. Patient-specific simulation may help in characterizing myocardial properties, and possibly in patient selection for the most appropriate electrical or biological therapy.