Personalized Modeling of Atrial Activation and P-waves: a Multimodality Approach

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Background: Biatrial in-silico models incorporating functional and anatomical features are becoming a promising tool for planning therapy for patients with atrial fibrillation. Conduction velocity (CV) is one of the most valuable electrophysiological parameters for identifying electrical abnormalities in the cardiac tissue. The spatial distribution of CV can be estimated from clinical measurements such as the P-wave duration from the ECG or local activation time (LAT) map.

Methods: Electrocardiographic imaging (ECGI) of two patients was obtained during sinus rhythm and coronary sinus pacing. The endocardial wall was segmented from magnetic resonance images (MRI) to generate patient-specific models including rule-based fiber orientation, inter-atrial connections and regional electrophysiological heterogeneity. After co-registration, LAT provided by ECGI were projected to the MRI geometry. Then, two different approaches were chosen. First, monodomain tissue conductivities were modified by an iterative process to match P-wave duration. Secondly, a reference activation map was defined by superimposing LAT from ECGI into the MRI nodes and by shifting a pre-computed atrial action potential template in time. ECGs were computed based on the infinite volume conductor assumption.

Results: Total depolarization time with the iterative method yielded to a mean P-wave duration difference of 0.7 ms between measured vs. simulated P-wave. Further adjustments to inter-atrial connections are needed to improve the fit of the depolarization pattern.