Modeling Structural Abnormalities in Equivalent Dipole Layer Based ECG Simulations

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Background: Inverse electrocardiography allows the estimation of the electric activity of the heart from recorded body surface potentials (BSP). One of the source models used is the equivalent dipole layer. In this model, the presence of diseased tissue breaks the equivalence of the dipole layer. In order to adequately simulate disease, we incorporated regions (patch) with altered source parameters within the myocardial tissue. Using this patch, the effect of pathological wave propagation on simulated BSP was assessed.

Methods: A boundary element method forward model based on a CT-based subject-specific heart/torso model (57y male) was used to compute the QRS complex from a 64-lead BSP. In three cardiac regions (**A**) an endocardial and epicardial patch were incorporated in the anatomical model. Normal activation was simulated using the fastest route algorithm with six endocardial foci. Pathological patch activation was computed for both a homogeneous and inhomogeneous substrate. Computed BSP were compared to the QRS complex of normal activation using correlation coefficient (CC).

Results: The presence diseased patch activation affect both QRS morphology and duration. Depending on substrate location, the agreement between QRS complexes was different amongst leads (**A**). A representative example for the effect of endocardial versus epicardial disease results in an opposing electrical vector observed in BSP (**B**).

Conclusion: A new method to describe the effect of cardiac disease in EDL-based ECG simulation was established. It was demonstrated that leads beyond the standard 12-lead configuration were affected depending on substrate location, indicating the importance of disease specific lead positioning. The insights obtained will further enhance risk-stratification and understanding of disease progression. Analysis will be extended towards the STT segment and simulations will be compared to clinical cases.

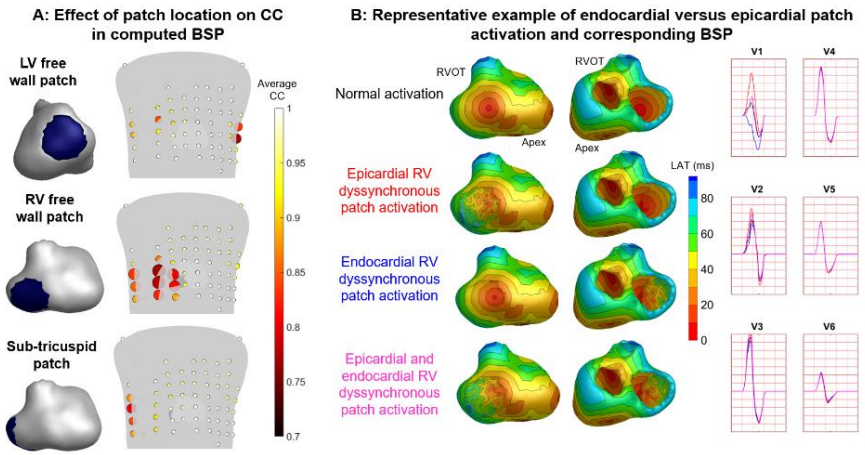

Figure – **A:** Effect of patch location (indicated in blue) in correlation coefficient (CC) between the normal and diseased QRS complex. The color of the dot indicates the average CC and the size of the dot indicates the standard deviation. **B:** Local activation timing (LAT) maps are displayed from red (early) to blue (late). Simulated QRS complexes are displayed per simulation for the precordial leads of the standard 12-lead ECG; colors in the left column indicating the type of patch simulation correspond to the colors of the QRS complex.