Comparison of Activation Times Estimation Methods for Potential-Based ECG Imaging

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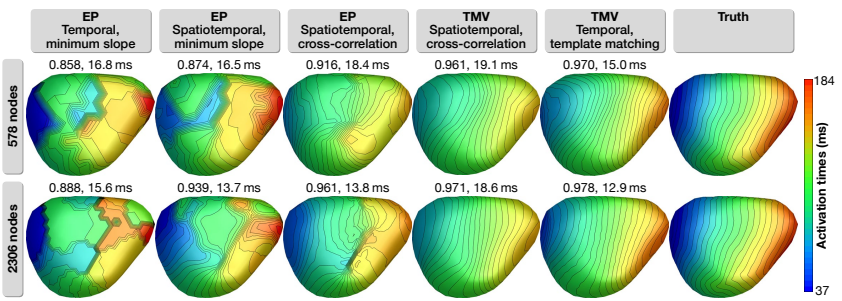
Activation times (AT) describe the sequence of cardiac depolarization and represent one of the most important parameters for analysis of cardiac electrical activity. However, estimation of ATs can be challenging due to multiple sources of noise such as fractionation or baseline wander. If ATs are estimated from signals reconstructed using electrocardiographic imaging (ECGI), additional problems can arise from over-smoothing or due to ambiguities in the inverse problem. Often, resulting AT maps show falsely homogeneous regions or artificial lines of conduction block. As ATs are not only important clinically, but are also commonly used for evaluation of ECGI methods, it is important to understand, where these errors come from.

We present results from a community effort to compare different methods for AT estimation on a common dataset. Body surface potentials (BSP) were calculated for three simulated pacings at the RV and LV lateral wall and the RV septum. White Gaussian noise was added to BSPs (mean SNR = 20 dB). ECGI reconstructions on the myocardial surface were performed for two mesh resolutions and using two different source models: extracellular potentials (EP) and transmembrane voltages (TMV), both using second order Tikhonov. ATs were then estimated by the community participants with 5 different methods for EPs and 3 different methods for TMVs and compared to the ground truth.

While the pacing site had the largest effect on AT correlation coefficients ($CC > 0.9$ for lateral and < 0.7 for septal pacings), there were also differences between methods and source models that were poorly reflected in CCs. Results indicate that artificial lines of block are most severe for purely temporal methods. More evaluation is needed regarding the effect of source models.



ATs for a pacing at the LV lateral wall. Numbers above images represent Pearson CC and MAE.