In Silico Computation of Electrograms and Local Electrical Impedance to Assess Non-Transmural Fibrosis

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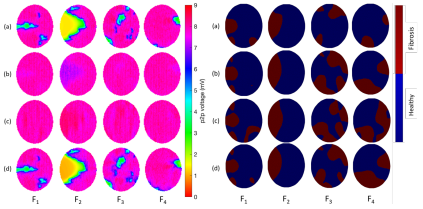
Introduction: Regions with pathologically altered substrate have been identified as potential proarrhythmic regions for atrial fibrillation. Mapping techniques, such as voltage maps, are currently used to estimate the location of these fibrotic areas. Recently, local impedance (LI) has gained attention as another modality for atrial substrate assessment as it does not rely on the dynamically changing electrical activity of the heart. However, its limits for assessing non-transmural and complex fibrosis patterns have not yet been characterized in detail. In this work, we study the ability of EGMs and LI to identify non-transmural fibrosis in different transmural locations using *in silico* experiments.

Methods: Models were developed to simulate the voltage maps and the LI maps. A pseudo-bidomain model was used to recover the extracellular potential on the surface of the tissue while a LI reconstruction was calculated by a time-difference imaging approach with a homogeneous tissue background conductivity. Four different fibrosis configurations were modeled to compare the two modalities (voltage map and LI map).



Voltage values and LI maps of each setting: endo- (a), midmyo- (b), epicardial (c), and transmural (d), for four fibrosis configurations F_{1-4}.

Results: Binary images were obtained from thresholding and comparison with the ground truth was performed for each modality using the Pearson correlation coefficient. Only one transmural structure was detected by voltage using a unipolar threshold of 1.32 mV. For voltage maps, all non-transmural structures yielded zero correlation, whereas the correlation for LI ranged from -0.02 to 0.74.

Conclusion: We conclude that LI can be used in combination with electrograms to account for fibrotic substrate. LI values are expected to distinguish between healthy atrial tissue and fibrotic areas, which paves the way towards the use of impedance as a surrogate for non-transmural atrial fibrosis substrate.