In Silico Local Impedance Mapping Using Multielectrode Catheters

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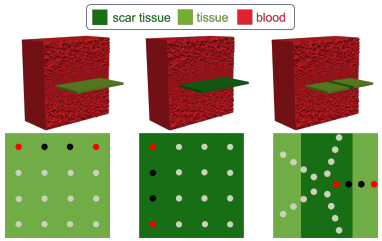
Introduction: Mapping techniques, such as voltage maps, are currently used to estimate the location of atrial substrate potentially causing atrial fibrillation. Local impedance (LI) has recently been introduced as another modality for atrial substrate assessment as it does not rely on the dynamically changing electrical activity of the heart. However, its potential has been mainly studied using point-by-point acquisitions with ablation catheters disregarding multielectrode mapping catheters. This study explores the ability of LI to assess catheter-tissue contact and identify healthy and scar tissue using *in silico* experiments.

Methods: Three-dimensional models of two mapping catheters with multielectrode arrangements were developed to measure LI in three tissue configurations. Combining 13 different stimulating bipolar pairs and five catheter-tissue distances, 195 simulated LI measurements were computed using forward electrical simulations at 14.5 kHz.



Simulation setup with a tissue patch in different scar configurations embedded in a box of blood with the exemplary bipolar electrode pairs.

Results: Increasing the catheter-tissue distance yielded monotonously decreasing LI values using both catheters. The grid catheter showed a median LI value on healthy tissue of 63.91 Ω, decreasing to 56.02 Ω at 2 mm distance. Similarly, the star catheter showed median LI values of 156.18 Ω and 115.13 Ω, respectively. The decreasing effect was also seen in scar tissue (52.77 Ω to 49.80 Ω, and 130.72 Ω to 111.28 Ω with a grid and star catheter, respectively). The presence of a scar line altered the LI measurements compared to the homogeneous patches.

Conclusion: *In silico* multielectrode LI measurements can be of help for identifying direct catheter-tissue contact and distinguishing between healthy myocardium or scar tissue underneath, paving the way towards its use as a surrogate for atrial substrate in clinical applications. In this work, scar tissue always yielded lower LI values than healthy scenarios for both catheters and all stimulating bipoles.