

Unipolar Electrogram Eigenvalue Distribution Analysis for the Identification of Atrial Fibrosis

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Background: Atrial fibrrosis plays a key role in the initiation and progression of atrial fibrillation (AF). Fibrotic tissue, typically characterized by a bipolar electrogram (EGM) peak-to-peak voltage lower than 0.5 mV, represents a target for AF ablation procedures. However, the sensitivity of bipolar EGMs with the catheter orientation and electrode contact limits this approach. The spatiotemporal information embedded in the signal is also disregarded with just considering peak-to-peak voltage. This work aims to propose a strategy for fibrotic areas detection using the dominant-to-remainings eigenvalue dispersion ratio (EIGDR) of unipolar EGMs within a clique of neighbor electrodes.

Materials and Methods: Unipolar EGMs from a 2-D atrial tissue were simulated including a circular fibrotic patch following Courtemanche model. Maps of three EIGDR (\mathcal{R} : ratio of first eigenvalue to the sum of all the others; \mathcal{R}^A : same ratio after u-EGMs ensemble alignment; and $\Delta\mathcal{R}^A$: the eigenvalue concentration gain by alignment) were obtained using two sizes of electrode cliques (3×3 and 2×2) for the eigenvalue analysis and two catheter-to-wavefront orientations (0° and 45°). Area under the curve (AUC) and detection accuracy (ACC) are used for performance evaluation.

Results: The proposed EIGDR markers showed potential to detect fibrosis. 3×3 cliques provided higher performance than 2×2 configuration. When catheter-to-wavefront orientation was 0° (45°), ACC reached values of 0.80 (0.69), 0.85 (0.80) and 0.91 (0.94) for \mathcal{R} , \mathcal{R}^A and $\Delta\mathcal{R}^A$, respectively.

Conclusions: EIGDR allows to discriminate fibrotic from non-fibrotic tissue areas, improving its performance when ensemble alignment is considered.

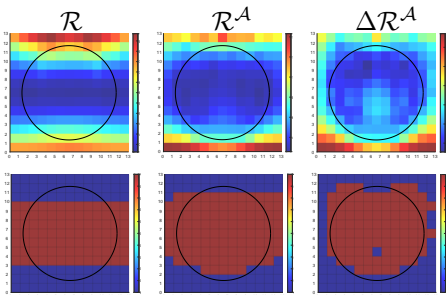


Figure 1. Top: markers maps for 3×3 cliques and catheter-to-wavefront orientation of 0° . Bottom: identification masks for maximum ACC thresholds.