High Coverage and High-Resolution Mapping of Repetitive Patterns During Atrial Fibrillation

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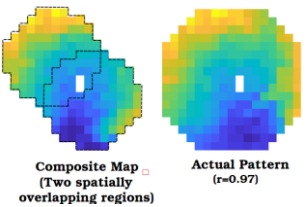
Aims: Localized AF drivers are candidate ablation targets for patients with persistent atrial fibrillation (AF). Spatiotemporally stationary drivers may be sources of repetitive atrial conduction patterns. High-density mapping electrodes cover only a fraction of the atria but combining sequential recordings could provide a bigger picture of common repetitive atrial conduction characteristics and enable AF driver localization. We developed a novel algorithm to merge overlapping local activation maps into larger composite maps of repetitive patterns.



Methods: Repetitive atrial conduction patterns were detected in epicardial high-density mapping of AF, using a recurrence plot-based approach based on the similarity of the activation-phase of all mapping electrodes over time. Cross-recurrences of repetitive patterns in sequential recordings were detected in spatially overlapping electrode locations. Local average activation maps were temporally aligned and combined into composite average activation maps based on detected cross-recurrences. The algorithm was applied to atrial recordings in a goat model of AF (249-electrode mapping array, 2.4 mm inter-electrode distance, n=16). Sequential, overlapping recordings were created by segmenting the mapping region into four spatially overlapping regions. Repetitive patterns were detected in the original data and reconstructed with the proposed algorithm. Reconstruction quality was measured as the Pearson correlation between original and reconstructed average activation patterns (see Figure).

Results: Composite maps were reconstructed for 121 repetitive patterns. Average correlation of original and reconstructed patterns was r=0.81±0.16. Reconstruction quality was positively correlated with pattern duration (r=0.38) and pattern size (r=0.35) but negatively correlated with pattern complexity (r=-0.41).

Conclusion: Composite maps of sequential high-density recordings of atrial conduction patterns provides a systematic way to reconstruct high-coverage and high-density atrial activation maps of repetitive patterns during AF. Application of the developed this methodology using the new generation of multi-electrode catheters could identify additional ablation targets.