Spatial Relationship Between Atrial Fibrillation Drivers and the Presence of Repetitive Conduction Patterns Using Recurrence Analysis on In-Silico Models

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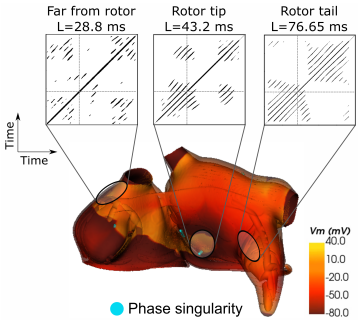
Aim: The outcome of catheter ablation for treatment of atrial fibrillation (AF) is still suboptimal, possibly due to the difficulty to identify AF drivers in the atria. Recurrence analysis is a technique that can be applied to detect the repetitive patterns that arise from organized conduction related to AF drivers and could be a valuable tool in their localization. In the present study, we aimed to understand the spatial relationship between repetitive patterns detected by recurrence analysis and the presence of rotors in an in-silico AF model.

Methods: AF was simulated in a detailed, high-resolution, three-dimensional model of the human atria, from which transmembrane potentials and electrograms (EGM) were obtained. The dataset consisted of 12 30-second AF simulations initiated by incremental pacing at different locations, with 70% of the atria composed of fibrotic cells distributed in patches. Phase singularities (PS), associated with rotors, were detected by analyzing phase differences in transmembrane potentials along the neighbors of each point in the anatomy. Simulated 4x4 electrode grids (3 mm spacing) were used to measure the EGMs of 15 regions in both atria. Recurrence plots (RP) were built from activation-phase signals obtained from the EGMs and diagonal line lengths were calculated to characterize the repetitive patterns. The distance between PSs and each electrode array was used to correlate the observed RPs with the rotor position.

Results: Continuous repetitive patterns were detected predominantly in electrode arrays close to the tail of the rotors, whereas discontinuous diagonal lines appeared when the tip of the rotor was moving directly underneath or close to the array. Distant electrode arrays presented recurrent patterns less frequently.

Conclusion: recurrent patterns identified from RPs seem to correlate with the localization of AF drivers, and may be used to guide ablation therapy.



Recurrence plot (2.5 s) patterns and rotor location (L: mean diagonal line length)