Tracking of Atrial Fibrillation Drivers Based on Propagation Patterns: an In-Silico Study

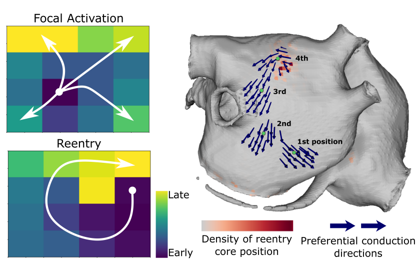
Victor G Marques, Ali Gharaviri, Simone Pezzuto, Angelo Auricchio, Pietro Bonizzi, Stef Zeemering, Ulrich Schotten

Maastricht University, Maastricht, Netherlands

Aim: in some persistent atrial fibrillation (AF) patients, localized drivers may be responsible for sustaining AF and thus represent possible ablation targets. Tracking drivers with surrogate parameters (e.g. dominant frequency) instead of focusing on the underlying conduction patterns has not yet led to significant improvements in ablation outcomes. Here, we aimed to locate AF drivers in an in-silico model using their characteristic propagation patterns.

Methods: a volumetric 3D atrial model was used to simulate 8 AF episodes for 11s. One stable reentry was generated per simulation (5 in left/ 3 in right atrium) with temporary block lines, and anchored to regions of inactive tissue permeated by random fibrotic paths (diameter 10mm). Sequential electrograms were obtained (1s segments, 4x4 electrode grid, 3 mm spacing) starting from 20 uniformly distributed points (12 left/ 8 right atrium). Conduction velocities and cycle length coverage (CLC) calculated for each AF cycle were used to connect sequential activation waves and detect propagation trajectories. Reentries were identified as trajectories with high curvature ($>120°$) and CLC>0.1, whereas focal activation was characterized by ≥ 2 trajectories propagating in different directions ($>70°$) with CLC<0.1. Conduction patterns were classified as reentries, focal activations, or exit points (focal activations in regions of inter-atrial connections). When no pattern was detected, an automatic source tracking algorithm moved the electrode array in 10mm steps upstream of the propagation direction. Algorithm performance was measured as correct reentry or exit point detection and number of steps required.

Results: the stable reentry's core was identified in 80.0% and 83.3% of starting points in the left and right atrium, respectively, requiring 6 (IQR: 4,10) steps. Other reentries or curves around anatomical structures were found in 2.5% of all starting points.



Examples of trajectory patterns and driver tracking algorithm

Conclusion: propagation patterns may be sufficient to track AF drivers sequentially during high-density mapping, especially under human supervision.