Influence of Gradient and Smoothness of Atrial Wall Thickness on Initiation and Maintenance of Atrial Fibrillation

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Aims: This study aimed to assess the role of spatial gradient and smoothing of atrial wall thickness on inducibility and sustainability of atrial fibrillation (AF) using highly detailed computational models of human atria.

Methods: An atrial model with homogeneous thickness (HO) derived from MRI-images was used as baseline for the generation of different atrial models including either a low (LG) or high thickness gradient between left/right atrial free wall and the other regions. Since the model with high spatial gradient presented non-natural sharp edges between regions, either 1 (HG1) or 2 (HG2) Laplacian smoothing iterations were applied.

Arrhythmic episodes were initiated using a rapid pacing protocol and long-living rotors were detected and tracked over time.

Thresholds optimised with receiver operating characteristic analysis were used to define high gradient/curvature regions.

Results: We observed the development of rotors when pacing precisely in the areas with high thickness gradient. Moreover, greater spatial gradients increased the atrial model inducibility and unveiled additional regions vulnerable to maintain AF drivers.

In the models with heterogeneous wall thickness (LG, HG2 and HG1), $73.5 \pm 8.7\%$ of the long living rotors were found in areas within 1.5 mm from nodes with high thickness gradient, and $85.0 \pm 3.4\%$ in areas around high endocardial curvature.

Conclusion: These findings promote wall thickness gradient and curvature as a priori measures to assess AF vulnerability and predict maintenance areas suitable for an ablation procedure.