Noninvasive One-Year Ablation Outcome Prediction for Paroxysmal Atrial Fibrillation using Trajectories of Activation from Body Surface Potential Maps

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Aims: Using spatiotemporal information from body surface potential maps (BSPM), we aimed to analyse preoperative atrial fibrillation (AF) dynamics to predict the one-year recurrence outcome after initial ablation success.

Methods: We hypothesised that the dipole direction of the heart during AF could be traced by the centroid trajectory of the principal "activated" electrode patches from the BSPM. We defined activated as being within 60% of the peak positive value. This was first verified in a simulated biophysical atria-torso forward model and AF patient data. The trajectory of each AF cycle was then used as a spatiotemporal feature to predict one-year AF-free outcome after ablation on 38 paroxysmal AF patients retrospectively, using a multiple instance classification framework. A Gaussian mixture model was used as a vocabulary builder and a linear support vector machine as a binary classifier.

Results and Conclusion: The correlation was assessed by the Pearson correlation coefficient on the frequency spectrum of the trajectory coordinates ϕ and z. A high correlation can be seen on z between torso and atria (0.87), and between torso ϕ and the V1 ECG signal (0.85) in simulated AF (Fig. left), as well as between V1 and torso z (0.78±0.12) and ϕ (0.74±0.10) over all patient signals. A leave-one-out test on our patient-level method showed 0.79 accuracy, 0.95 sensitivity and 0.56 specificity, with the area under the curve (AUC) of receiver operating characteristic being 0.85 (Fig. right), outperforming other standard metrics, such as cycle length (CL), nondipolar component index (NDI), and spatial variability (SPV), suggesting that the proposed trajectory during paroxysmal AF can improve one-year ablation outcome prediction.