Peak-Based Spatio-Temporal Dispersion Classifier of Multipolar Intracardiac EGM in Persistent Atrial Fibrillation

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Abstract

Introduction: *Atrial fibrillation (AF) is a heart condition primarily affecting the elderly. Catheter ablation (CA) is the most effective long-term solution for persistent AF. A novel CA approach, centered on spatio-temporal dispersion (STD), linked to zones sustaining the arrhythmia, has been proposed. STD areas are clusters of EGMs, that display interelectrode spatio-temporal dispersion at a minimum of two adjacent bipoles such that activation spreads over more than the 50% of the AF cycle length. Our objective is automatically classify STD in 10 lead multipolar electrograms (EGM), without relying on machine learning (ML).*

Challenges: *STD classification at the block involves visually detecting peaks to identify local activations time shift. Conventional signal processing methods often fall short.*

Methods: *We built a peak based mathematical pipeline. It mimics the cardiologist classification process. It breaks the signal in frames of 0.162 seconds (average AF cycle length). It identifies peaks as global maximum per window, corresponding to local activations. Following the STD definition AF activation time is compared. The possible cases are: i) no time shift (no STD), ii) time shift (STD): a) constant $> 50\%$ AF cycle length, b) intermittent, c) gradually increasing, iii) others (no STD).*

Results: *The dataset is composed by 430 samples (10 leads each), 112 STD and 318 non STD. Data acquired from 53 persistent AF patients at Nice Pasteur University Hospital, relabeled offline to remove annotation errors. Local activation is considered as peak of interest, per each cycle to identify if STD occurs or not. F1 score is 0.571, (Acc 0.549 AUC ROC 0.510 PPV 0.270 Sens 0.429 NPV 0.746 Spec 0.592) comparable to 0.41 obtained with ML.*

Conclusion: *Results underscore the importance of identifying peaks to classify STD. Over ML, The explanatory mathematical approach gains in performance and improves interpretability, for cardiologists.*

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