

Non-invasive Mechanism Classification and Localization in Supraventricular Cardiac Arrhythmias

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Aims: Atrial tachycardia (AT), flutter (AFL) and fibrillation (AF) are common supraventricular arrhythmias driven by localized sources, needing invasive electrophysiological procedures to guide ablation of target mechanisms. Previously, we showed that dominant frequency (DF) and phase singularity point (SP) biomarkers, calculated from body surface potential mapping (BSPM), allow non-invasive arrhythmia classification and mechanism localization. In this study, we extend the analysis through improved classification statistics and ranked biomarker relevance.

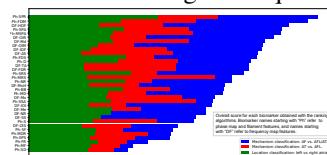
Method: We used 19 simulations (AT=4, AFL=4, AF=11) of 567-lead BSPMs to generate DF maps and estimate driver frequencies with the highest DF (HDF). 34 biomarkers were extracted from DF and phase maps based on the general DF distribution, organization index (OI) and characteristics from HDF regions (HDFr) with $|DF - HDF| \leq 1Hz$, and from temporally connected SPs (filaments) and their histograms, representing rotational activity.

Arrhythmia classification: biomarker ranking was performed with ANOVA, Kendall and Lasso techniques, and the 4 best biomarkers were identified to discriminate: a) AF from AFL/AT, and; b) AFL from AT (8 biomarkers in total). Driver localization in left vs right atria: the torso was divided into four overlapping regions; the best two biomarkers were extracted from each division (total=8) based on the same ranking strategies. Classification was performed using the best biomarkers with hierarchical clustering and logistic regression.

Results: Arrhythmia classification accuracy was 89.47%. Mean filament displacement, mean OI, and number and standard deviation of HDFr area best distinguished AF from AFL/AT; mean HDFr area and 3 SP biomarkers best distinguished AFL from AT, with good agreement across ranking techniques.

For classification of mechanism location, overall accuracy was 84.21%, with the most important biomarkers being percentage SPs within each torso division, and standard deviation of filament histogram cluster area.

The figure summarizes our results.



Conclusion: Classification of atrial arrhythmias and their driver locations is feasible with a reduced number of biomarkers.