A Machine Learning Approach to Automated Localization of Targets for Ventricular Tachycardia Ablation Using Sinus Rhythm Signal Features

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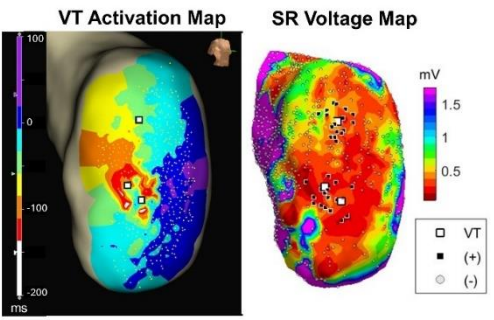
Background: Catheter ablation has the potential to become an effective treatment for ventricular tachycardia (VT), but the current identification of ablation sites relies on the operator's judgement and experience.

Aims: To propose a novel machine learning approach to identify ablation targets based on signal features derived from intracardiac electrograms recorded in sinus rhythm.

Methods: 56 substrate maps were collected during pacing and sinus rhythm using a multipolar catheter (Advisor HD grid, Ensite Precision) in 13 pigs with chronic myocardial infarction (n=31,515 mapping points). 35 VTs were induced and critical components of the VT circuit including early-, mid- and late-diastolic signals, were localized. Cardiac sites within 6 mm from these critical VT sites were considered as potential ablation targets (7.4% of all cardiac sites). 47 features representing signal morphology, function, spatial and spectral properties were extracted from each bipolar and unipolar signal recorded during pacing or sinus rhythm. A random forest algorithm was trained on 80% of the data to identify the 20 most important features and 10 times 10-fold cross-validation was performed on an under-sampled training set (1:5 ratio for positive: negative class) to identify the best performed model for validation on test set.



White squares: VT sites
Black squares: Prediction sites

Results: The average performance from cross-validation on training set showed an area under the ROC curve (AUC) of 86.7%, with a specificity of 79.7% and a sensitivity of 79.2%. Validation on the remaining 20% of super imbalanced test data still showed a stable result, with an AUC of 87.2%, a sensitivity and a specificity of 78.3% and 81.7%, respectively, for the best model.

Conclusion: This study demonstrates for the first time that machine learning may support clinicians in the localization of targets for VT ablation.