

A machine learning based approach on the value of 12-lead ecg to predict success of catheter ablation for atrial fibrillation

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Background: The standard 12-lead electrocardiogram (ECG) offers a universally available and cost-effective method for assessing and quantifying individual electrical characteristics of the left atrium in patients with atrial fibrillation (AF).

Purpose: To evaluate the prognostic value of pre-procedural 12-lead ECGs for predicting atrial fibrillation (AF) recurrence after catheter ablation (CA).

Method: Consecutive patients referred for CA of AF between May 2010 and November 2024 were included. Standard 10s 12-lead ECG were performed the day before and after CA. A dataset of 313 automatically extracted ECG features (standard features plus lead dependent Pwave characteristics, including duration, amplitude, axis, and morphology) using a dedicated toolbox (Schiller AG, Switzerland) were combined with three machine learning methods (random forest (RF), support vector machine (SVM), neural networks (NN)) to (1) predict the timing of the ECG acquisition (before or after CA) due to ablation induced feature changes (primary object) and (2) to predict recurrence of AF over a follow-up of 1 year (secondary objective) based on the pre-procedural ECG in sinus rhythm (SR).

Results: Among the 2966 patients, 4996 SR ECGs before and after CA for the primary and 1035 SR ECGs before CA for secondary objective were analyzed. Primary objective of ECG identification was reliably reached for all ML models with a ROC AUC between 0.854 (RF) and 0.868 (NN) in the internal test cohort (Figure; upper row) and between 0.669 (RF) and 0.779 (NN) for an external test cohort of 200 ECGs (lower row). For prediction of AF recurrence, none of all tested models showed significant discrimination (best ROC AUC = 0.522), indicating the lack of explanatory value of pre-procedural ECGs for the prediction of AF recurrence.

Conclusion: Although the distinction between ECG characteristics before and after catheter ablation in patients with atrial fibrillation is reliable, the ablation-induced ECG parameter in general and Pwave characteristics in specific do not predetermine the recurrence of atrial fibrillation in our cohort. Whether incorporating additional patient characteristics or modeling AF burden as an endpoint could improve predictive performance warrants further investigation

Performance of ECG timing prediction

