A machine learning classification algorithm to detect patients with paroxysmal atrial fibrillation during sinus rhythm

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Citation:
Background: Atrial fibrillation (AF) - the most common sustained cardiac arrhythmia - while not a life-threatening condition itself, leads to an increased risk of stroke and high rates of mortality. Early detection and diagnosis of AF is a critical issue for all health stakeholders.

Purpose: The aim of this study is to identify P-wave morphology patterns encountered in patients with Paroxysmal AF (PAF) and to develop a classifier discriminating PAF patients from healthy volunteers.

Methods: Three-dimensional 1000Hz ECG signals of 5 minutes duration were obtained through the use of a Galix GBI-3S Holter monitor from a total of 68 PAF patients and 52 healthy individuals. Signal pre-processing, consisting of denoising, QRS auto-detection, and ectopic beats removal was performed and a signal window of 250ms prior to the Q-wave (Pseg) was considered for every single beat. P-wave morphology analysis based on the dynamic application of the k-means clustering process was performed. For those Pseg that were assigned in the largest cluster, the mean P-wave was computed. The correlation of every P-wave with the mean P-wave of the main cluster was calculated. In case that it exceeded a prespecified threshold, the P-wave was allocated to the main morphology. For the remaining P-waves, the same approach was followed once again, and the secondary morphology was extracted (picture). The P-waves of the dominant morphology were further analyzed using wavelet transform, whereas time-domain characteristics were also extracted.

A Support Vector Machine (SVM) model was created using the Gaussian Radial Basis Function kernel and the forward feature selection wrapper approach was followed. ECGs were allocated to the training, internal validation, and testing datasets in a 3:1:1 ratio.

Results: The percentage of P-waves following the main morphology in all three leads was lower in PAF patients (91.2 ±7.3\%) than in healthy subjects (96.1 ±3.5\%, \(p = 0.02\)). Classification between the two groups highlighted 7 features, while the SVM classifier resulted in a balanced accuracy of 91.4±0.2\% (sensitivity 94.2±0.3\%, specificity 88.6±0.1\%).

Conclusion: An Artificial Intelligence based ECG Classifier can efficiently identify PAF patients during normal sinus rhythm.
Abstract: A machine learning classification algorithm to detect patients with paroxysmal atrial fibrillation during sinus rhythm.

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