Supervised Classification of Brugada Syndrome Patients by ECG-derived Markers

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Background. Brugada syndrome (BrS) is an inherited cardiovascular channelopathy associated with risk of ventricular fibrillation and sudden cardiac death (SCD). BrS is characterized by a typical electrocardiographic pattern which can be variable and sometimes remain hidden, affecting its diagnosis. The risk stratification and management of patients remains challenging as the only accepted risk is the presence of resuscitated cardiac arrest or arrhythmogenic syncope and the vast majority of patients are diagnosed in the pre-clinical (asymptomatic) phase with an annual incidence of SCD of 0.5%-1%.

Aims. The study aimed to test Machine Learning (ML)/supervised classification tools to prognosticate symptomatic BrS patients from ECG-derived markers related to depolarization and repolarization phases.

Methods. 12-lead ECG 24-h Holter recordings from 45 BrS patients, both symptomatic and asymptomatic, were used. ECG signals were divided in 3-minute segments for signal-averaging to reduce noise. ECG beats were automatically delineated to obtain: absolute value of the QRS area, average power of the QRS, QT and corrected QT interval, ST amplitude at J-point and at J-point + 60 ms, and ST segment slope from the two previous values. Subsequently, 3 different ML/supervised algorithms based on a decision tree, k-nearest neighbors and support vector machine algorithms were tested, using different approaches of training, validation and test datasets.

Results. Of the 45 patients included in this study only 8 (18%) were previously diagnosed as symptomatic. ECG-markers were obtained from 18999 signal-averaged beats. ST slope, QRS area and QRS power were significantly higher in symptomatic patients in some precordial leads ($p<0.001$). Results were consistently strong on validation datasets (overall accuracy of 98.5% and symptomatic true Positive rate of 97.7%); however, overall accuracy on test datasets were of 54,7% with asymptomatic/symptomatic true positive rate of 87%/25% to 67%/30%, according to the classifier algorithm. The reduced number of symptomatic patients was an important limitation of the study.

Conclusions. The ECG-based markers used in this study, by themselves, do not efficiently predict BrS symptomatic patients at risk of sudden death, with ML algorithms. Further studies with additional ECG indices and clinical information may improve this prognosis.