

Spectral Distribution Complexity of the Surface Fibrillatory Waves Predicts Post-Catheter Ablation Relapse in Persistent Atrial Fibrillation

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Background and Aim. Atrial fibrillation (AF) is the most diagnosed cardiac arrhythmia and a major and growing public health problem. Catheter ablation (CA) is the first-line treatment for AF but still has a high recurrence rate of about 35% within the first year for persistent AF. Preoperative CA outcome prediction is currently of clinical interest to select those patients who really would benefit from the procedure. This work introduces a novel fibrillatory waves (f -waves) spectral distribution metric from the preoperative surface electrocardiogram (ECG) to anticipate CA long-term outcome.

Methods. The f -waves were extracted through a QRST cancellation method from the preprocessed 6-s length, V1-lead surface ECG of 74 persistent AF patients before undergoing CA, of which 19 relapsed to AF after a follow-up of 9 months. In addition to the f -waves amplitude (FWA) and dominant frequency (DF), which have already reported promising predictive abilities, the C_0 complexity was firstly addressed in this study. Its calculation requires dividing the power spectral density (PSD) of the f -waves into two divergent components. For this purpose, different thresholds θ were considered by multiplying the mean value of the PSD of the f -waves by a factor ranging between 1.5 and 2.5.

Results. All C_0 complexity indices reported statistically significant differences between patients who maintained sinus rhythm (SR group) and those who relapsed to AF (AF group), as well as higher values of sensitivity (Se), specificity (Sp), and accuracy (Acc) than the DF and FWA (see table below). Moreover, the combination of DF and C_0 complexity, computed with $\theta = 2$, via a decision tree of only five splits improved classification until values of Se, Sp and Acc of 75.33, 77.33 and 76.58%, respectively.

Conclusions. The spectral distribution complexity of the f -waves contains information able to improve CA outcome prediction for persistent AF patients.

Index	SR group	AF group	p -value	Se (%)	Sp (%)	Acc (%)	AUC (%)
DF (Hz)	5.45±1.02	5.92±0.93	0.036	63.16	61.82	62.16	66.22
FWA (μ V)	38.27±27.94	48.76±25.73	0.065	63.16	61.82	62.16	64.31
$C_{0.1.5\theta}$ (%)	26.85±6.77	23.19±4.26	0.004	69.09	68.42	68.92	72.44
$C_{0.2\theta}$ (%)	32.40±8.58	27.58±5.84	<0.001	70.91	68.42	70.27	75.50
$C_{0.2.5\theta}$ (%)	37.27±10.21	31.68±6.95	0.004	69.09	68.42	68.92	72.15