Multidimensional Characterization of the Atrial Activity to Predict Electrical Cardioversion Outcome of Persistent Atrial Fibrillation

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Background and Aim. European Society of Cardiology guidelines recommend electrical cardioversion (ECV) as a rhythm control strategy in persistent atrial fibrillation (AF). Although ECV initially restores sinus rhythm (SR) in almost every patient, mid- and long-term AF recurrence rates are high, so that additional research is needed to anticipate ECV outcome and rationalize the management of AF patients. Although indices characterizing atrial activity (AA) from surface lead V1, such as dominant frequency (DF), amplitude (FWA), and entropy, have reported good results, they discard the spatial information from the remaining leads. This work explores whether a multidimensional approach of these parameters can improve ECV outcome prediction.

Methods. Fifty-eight patients undergoing ECV were enrolled in the study, 27 of them maintaining SR after a follow-up of 4 weeks. From each one, a 90 s-length, 12-lead ECG recording was acquired. Then, an adaptive QRST cancellation algorithm was used to extract AA from each lead. Multidimensional FWA was then computed using a previously published algorithm, based on the first-rank principal component decomposition of all AA signals. Multidimensional DF was estimated over the spectral envelope, and multivariate sample entropy (MSampEn) was also computed. As a reference, unidimensional FWA, DF and SampEn were estimated over V1.

Results. Multidimensional FWA provided similar accuracy (Acc) to its unidimensional version, but with more balanced values of sensitivity (Se) and specificity (Sp), see the table below. A better tradeoff between Se and Sp was also seen for DF, but this metric reported a lower Acc in the multidimensional case. Contrarily, MSampEn improved Acc by 5.5% regarding SampEn, increasing Sp by 18%.

Conclusions. Multivariate entropy analysis could estimate some previously unrevealed AA dynamics, thus improving ECV outcome prediction.

Parameter	Unidimensional version			Multidimensional version		
	Se(%)	Sp(%)	Acc(%)	Se(%)	Sp(%)	Acc(%)
FWA	40.7	77.4	54.2	48.4	66.7	54.6
DF	80.6	59.3	75.7	71.0	74.1	72.1
SampEn	80.6	63.0	74.7	74.2	81.5	80.3