Model-Based Characterization of Atrial Fibrillation Episodes and its Clinical Association

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Aim: Studies investigating risk factors associated with atrial fibrillation (AF) have mostly focused on AF presence and burden. However, this parameter does not say anything about the temporal distribution of AF episodes, although such information can be also relevant. In the present study, using a novel model-based approach to characterizing paroxysmal AF episode patterns, the association between echocardiographic measurements and model parameters accounting for rhythm dominance and episode clustering is investigated.

Materials and methods: Long-term, 3-lead ECG recordings from 12 patients with paroxysmal AF, lasting from 1 to 7 days were available. AF detection was performed involving information on ventricular rhythm, atrial rhythm and f-wave morphology, followed by a manual review by an expert. Thereafter, history-dependent point process modeling was employed to characterize AF episode patterns, using a novel alternating, bivariate Hawkes model. In this model, a transition from non-AF to AF (or vice versa) increases the likelihood of observing additional transitions in the near future, thus allowing clustered transition patterns to be modeled. Two parameters: the intensity ratio \( \mu \), describing the dominating rhythm (AF or non-AF) and the exponential decay \( \beta \) providing information on clustering, were investigated in relation to AF burden and atrial echocardiographic measurements.

Results: Both \( \mu \) and \( \beta \) are weakly correlated with atrial volume (\( r=0.19 \) and \( r=0.34 \), respectively), whereas \( \mu \) is correlated with atrial strain (\( r=-0.74, p<0.1 \)) and AF burden (\( r=0.68, p<0.05 \)). Finally, low correlation between clustering parameter \( \beta \) and AF burden was found (\( r=0.29 \)).

Conclusion: As atrial structural remodelling is associated with changes in AF characteristics, often manifested as episodes of increasing duration (increasing \( \mu \)), thus \( \mu \) may reflect the degree of atrial electrical and structural remodelling. Moreover, \( \beta \) provides complementary information to AF burden and may be useful for risk assessment and better understanding of arrhythmia progression.