Unsupervised k-mean classification of atrial electrograms from human persistent atrial fibrillation

Tiago P. Almeida[1], Diogo C. Soriano[2], Xin Li[3], Gavin S. Chu[3], João L. Salinet[2], Fernando S. Schlindwein[3], Peter J. Stafford[3], G. A. Ng[3], Takashi Yoneyama[1]

[1] Aeronautics Institute of Technology, Brazil; [2] Federal ABC University, Brazil; [3] University of Leicester, UK

Introduction – The discretized criteria for atrial electrogram (AEG) classification as proposed by commercial systems (fractionated/not-fractionated) to guide ablation has been shown insufficient for persistent atrial fibrillation (persAF) therapy. In this study, we used unsupervised classification to investigate possible sub-groups of persAF AEGs.

Methods – 3745 bipolar AEGs were collected from 13 persAF patients after pulmonary vein isolation. Automated AEG classification (fractionated/not-fractionated) was performed using the CARTO criteria (Biosense Webster). The CARTO attributes (ICL, ACI and SCI) were used to create a 3D space attribute. K-mean with five groups and Euclidean distance was implemented. The five groups were compared with each other (median [IQR]).

Results – Group 1 (43%) represents not-fractionated AEGs with low ICL (1.0 [1.0-2.0]), high ACI and SCI (110 [108-110] ms; 110 [107-110] ms). Group 2 (15%) has shown highly fractionated AEGs with high ICL (20 [17-24]), low ACI and SCI (75.0 [72.5-78.3] ms; 50.0 [50.0-50.8] ms). Groups 3 (9%) and 4 (9%) have shown similar low ICL (3 [1-5]; 2 [1-4]), but Group 3 has shown AEGs with short activation intervals (ACI 65.0 [57.5-69.2] ms; SCI 53.3 [50.8-57.5] ms), as opposed to Group 4 (ACI 87.5 [82.5-91.7] ms; SCI 78.3 [71.7-85.0] ms). Group 5 (23%) suggests moderated fractionation (ICL 8 [5-11]), with high ACI (80.0 [76.7-83.3] ms) but low SCI (54.2 [51.7-58.3] ms). The three attributes were significantly different among the five groups (P<0.0001), except ICL between Groups 3 and 4 (P>0.999) and SCI between Groups 3 and 5 (P>0.999).

Conclusions – The results suggest that discretized AEG classification is insufficient to describe persAF and should be revisited. The unsupervised classification proposed by the k-mean has found five sub-groups of AEGs with distinct characteristics, each of which could represent different electrophysiological mechanisms. This could provide a more detailed characterization of the atrial substrate during persAF ablation.