# Morphological Study of Intracardiac Signals as a New Tool to Track the Efficiency of Stepwise Ablation of Persistent Atrial Fibrillation

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Purpose: Intracardiac organization indices such as atrial fibrillation (AF) cycle length (AFCL) have been used to track the efficiency of stepwise catheter ablation (step-CA) of long-standing persistent AF (per-AF), however, with limited success. The morphology of AF activation waves (MAW) reflects the underlying activation patterns. Our study aims at assessing AF organization during step-CA using the temporal evolution of MAW based on recurrence plots (RP). Methods: 5 patients with per-AF (age $60\pm4$, duration $16\pm10$ months) successfully underwent step-CA consisting of pulmonary veins isolation (PVI), ablation of fragmented potentials and left atrial lines until AF termination (i.e. restoration of sinus rhythm/conversion to atrial tachycardia). Bipolar signals from the right atrial appendage (RAA) were continuously recorded and split into 10-sec epochs. Atrial activation times were estimated using MAW barycenter. The dissimilarity d(.,.) between two MAWs was defined as their cosine distance. For each epoch with N MAWs, the RP was defined as the NN binary symmetric matrix with one at location (i,j) if d(AWi, AWj) = pi/7, and zero otherwise. Two parameters were extracted: the proportion of recurrence points (REC) and the entropy (ENT) of line lengths parallel to the main diagonal. Results: ENT was significantly higher (rank test, $p<0.05$) than that of surrogates (random locations of the AWs), indicating a deterministic structure in MAW temporal evolution. The evolution (in %) of mean REC and ENT values during PVI vs baseline was compared to that of RAA AFCL. The table shows that REC/ENT of MAW displayed large variations during PVI while AFCL did not. Conclusions: Our preliminary results suggest that the analysis of MAW is superior to AFCL to track the effect of step-CA en route to AF termination. Interestingly, PVI as the first step of AF ablation may produce some morphological variations whose clinical usefulness needs to be further investigated.