Dynamic Behavior of Rotors during Human Persistent Atrial Fibrillation as observed using Non-Contact Mapping

Date Published
11-09-2016.

Authors:
Nawshin Dastagir*, Tiago Almeida*, Xin Li*, Frederique J Vanheusden*#, Gavin S Chu', Peter J Stafford*, G Andre Ng*' and Fernando S. Schlindwein*

Affiliations:
* Department of Engineering, University of Leicester, UK
# ISVR, University of Southampton, UK
' Department of Cardiovascular Sciences, University of Leicester, UK;

Abstract:
Rotors have been related to atrial fibrillation (AF) maintenance. We analyzed the behavior of rotors in persistent AF (persAF) utilizing a novel non-contact methodology and compared this to real time dominant frequency (DF) analysis. 2048 noncontact virtual unipolar atrial electrograms (AEGs) were collected simultaneously (EnSite Array, St.Jude Medical) from 10 persAF patients (duration: 34±25months) undergoing left atrial (LA) ablation. After QRSTremoval, FFT was used to identify the global DF of the LA (range 4- 10Hz; 1s time-window; 50% overlap; highest-DF (HDF) (DF-0.25Hz); up to 20s/patient). The frequency organization of AEGs was measured by the organization index (OI). Phase was found via Hilbert-transform. Phase singularities (PSs) and their chirality were identified and tracked. The PSs were categorized according to their lifespan into short (lifespan <80ms) and long-lived (rotors) (lifespan ≥80ms) (Fig-1A). A total of 6261 PSs were tracked. 5.2% (IQR: 0.44~5.7%) of the tracked PSs were long-lived (Fig-1A) and were observed in 20% (IQR: 2.5~35%) of the windows. The numbers of PSs observed at any instant are shown in Fig-1B, demonstrating that 60% of the time no PSs were observed. Furthermore, up to 13 PSs were also observed at any time instant and complex clustering of PSs were seen. Fig-1C illustrates complex PSs clustering for one patient during 1.5s. The window with rotors showed significantly higher HDF (mean±SD, 8.0±0.43Hz vs 7.71±0.53Hz, $p<0.0001$) and lower OI (0.76±0.04 vs 0.79±0.03, $p<0.0001$) when compared with the short-lived PSs window (Fig-1D). During persAF, the LA showed distinct behaviors as characterized by rotors. Often, no rotors were observed during sustained AF and, when present, the rotors continually switched between organized and disorganized behaviors. Long-lived rotors correlated with higher atrial rates. From these data we conclude that rotors are not the sole perpetuating mechanism in persAF and that dynamic DF analysis can identify sites of long-lasting rotor activity.