Correlation-based Estimation of Activation Frequency in Intracardiac and ECG signals during Atrial fibrillation

Duna de Luis-Moura, María Termenón-Rivas, Javier Barrios-Álvarez de Arcaya, Giada S. Romitti, Alejandro Liberos, Miguel Rodrigo

CoMMLab, Universitat de València,València, Spain

Estimation of the atrial Cycle Length (CL) can help to identify atrial regions sustaining atrial fibrillation (AF), although the complexity of AF patterns possess a challenge. This work explores correlation-based methods to estimate atrial CL in intracardiac (EGM) and electrocardiographic (ECG) signals.

In 4 AF patients, we collected 6-seconds N=2560 EGMs and N=1920 ECG signals, using simultaneous 64-poles basket catheter to 48-electrodes body surface system. In N=96 EGM traces, atrial CL was visually annotated. Two correlation-based method were used to estimate atrial rate in EGM/ECG signals: 1. the local maxima of the signal autocorrelation; 2. the median time difference between local maxima in the convolution of the signal with a template (100ms of the same signal), averaging medians between N=5, 10, 20 random templates (A). Simultaneous EGM and ECG signals were compared by accounting the percentage of intracardiac CLs that were present in any of the 48 ECG CLs with a deviation lower than 5 ms.

The autocorrelation provided local maxima corresponding to the correct CL (A up), although some signals with beat-to-beat variations showed secondary local maxima at incorrect CLs (A middle, ~15 act. in 3 s. ≠329 ms) which could be solved by the convolution-based method (A down, 195 ms). Autocorrelation-based method showed a relative error or 31±16% respect EGM annotations, whereas convolution-based methods showed relative errors lower than 20% (fig. B, $p<0.05$). Simultaneous intracardiac vs non-invasive CL metrics (fig. C) also indicated that convolution-based method with 5 templates had the highest agreement between EGM and ECG CLs (97±5%) compared to the autocorrelation method (91±8%) or using more templates.

Convolution-based methods using templates of the same signals allowed an accurate estimation of the atrial CL for both intracardiac and non-invasive electrocardiographic signals. This method may help to stratify and guide therapies based on the presence of high-frequency AF drivers.