Reply to correspondence by Alcarez R and Rieta JJ

We really appreciate all value comments from Prof. Alcaraz and his colleague. According to the analysis of surface ECG from AF patients, the most prominent atrial signals in lead V1 are usually selected[1] due to the highest ratio of AF signal amplitude to QRS amplitude. The main algorithm before using QRS-T cancellation technique was divided into 2 processes: R peak detection and T-wave end location. First, R peak was detected by parabolic fitting algorithm using a second degree polynomial to fit the ECG signal inside a sliding window around the signal sample.[2] The indicator signal was computed at each sample corresponding to its curvature and height, thereby the biggest peak of the indicator signal in each cardiac cycle corresponded to the R peak, which was located by thresholding method.[2] And the Q onset was identified as the point at which the amplitude range of a 30 ms sliding window fell to its minimum within a 120 ms interval before the R peak.[3] Second, an interval between 2 successively detected R peaks was roughly delimited to confine T-wave end search (without overlapping with other wave forms) using sliding window width and morphology threshold specification functions.[2,4] For each time instant inside the RR interval, the value of the area indicator was computed and considered as T-wave morphology (positive, negative, or biphasic) so that the latest instant maximizing or minimizing this area indicator corresponded to the T-wave end.[4] Then, the QRS-T complex was identified as the interval from QRS onset to T-wave end. Finally, the TQ interval was obtained and soft unions of the signals were done, by a softened extremes window and 10% overlapping between consecutively joined signals[3], for further SampEn and AFR analysis (Figure 1).

Signal analysis for SampEn and AFR

In this study, at least one-minute long ECGs from lead V1 were proceeded to extract TQ interval or AA by cancellation of QRS-T complex using combined algorithms applied from those previously developed by Zhang *et al*.[4], Alcaraz *et al*.[3], and Bollmann *et al*.[1] Thereafter, SampEn analysis was carried out from the 10-second long consecutive TQ interval. And AFR analysis was also performed on the same TQ interval mentioned above. Briefly, spectral analysis was applied to create power spectrum by FFT, then the atrial fibrillatory frequency (in Hz) was identified from the highest spectral peak and turned into AFR in fibrillations per minute or fpm by multiplying with 60.

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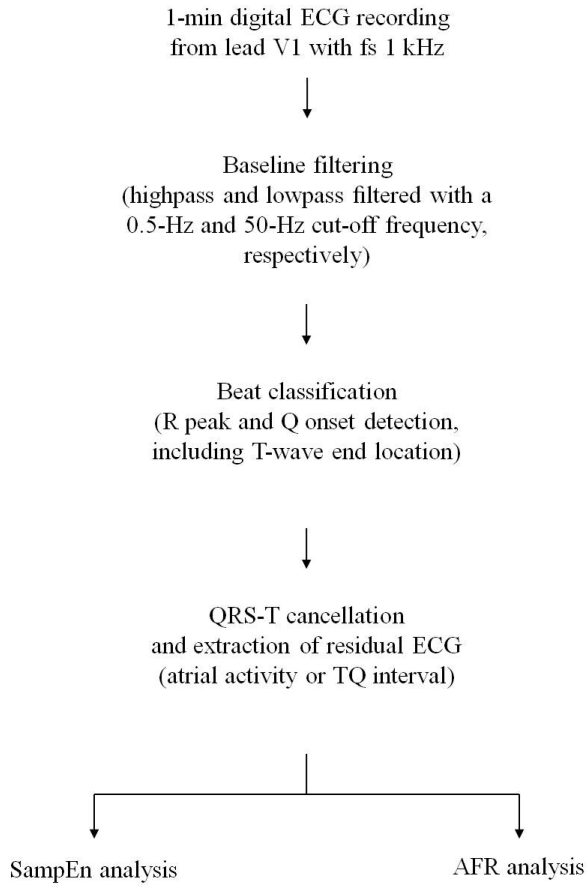

Figure 1: Diagram illustrates signal processing technique to acquire TQ interval or atrial signals without ventricular activities, which were extracted from ECG by cancellation of QRS-T complex.
AFR = atrial fibrillatory rate, fs = sampling frequency, SampEn = sample entropy