T-Wave Alternans Quantification: Which Information from Different Methods?

Laura Burattini*, Silvia Bini and Roberto Burattini

Department of Biomedical, Electronics and Telecommunication Engineering, Polytechnic University of Marche, Ancona, Italy

Several computerized methods have been proposed in the literature for detection and quantification of T-wave alternans (TWA), an ECG phenomenon consisting of every-other-beat changes in the T-wave morphology. In the absence of a standardized quantitative definition of TWA, a question arises about the quantitative information provided by each TWA identification method. In the effort to identify differences in TWA quantification, three methods were considered in the present study, namely, the fast-Fourier-transform spectral method (FFTSM), the modified-moving-average method (MMAM), and our heart-rate adaptive match filter method (AMFM). These techniques were applied to two synthetic ECG tracings affected by stationary TWA having: 1) a triangular profile (TRI_TWA), characterized by an alternans mostly localized around the T-wave apex, with T-waves maximum-amplitude difference (AMAX) of 100 V and mean-amplitude difference (AMEAN) of 50 V; and 2) a uniform profile (UNI_TWA), characterized an alternans uniformly distributed over the T waves, with AMAX= AMEAN=100 V. When analyzing TRI_TWA, TWA quantification by the FFTSM, the MMAM, and the AMFM was 57 V, 100 V, and 50 V, respectively. Instead, when analyzing UNI_TWA, all three methods provided 100 V TWA amplitude. Comparing these estimates with the simulated values of AMAX and AMEAN, we can infer that the FFTSM and the AMFM provide TWA quantification in terms of AMEAN, while the MMAM provides AMAX. Thus, an equivalent quantification of TWA amplitude can be expected from the three different methods only in the presence of the ideal case of uniformly distributed TWA. In more realistic conditions, like the one simulated here by a triangular profile, quantification more properly related to mean TWA amplitude is provided by the FFTSM and the AMFM, whereas maximum amplitude information is provided by the MMAM. These differences in TWA quantification have to be taken into account for objective comparison of TWA identification methods.