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The effect of U-shaped patterns to nonlinear properties of heart rate variability

U-shaped patterns, characteristic periods of time observed in tachograms, are acceleration-deceleration events characterized by high persistency of RR time intervals, a longer acceleration time than deceleration, and duration within 20-40 seconds. Percentage contribution of U-shaped patterns is small (in average 3%) compared to the whole nighttime series. However, the occurrence of U-shaped patterns affects to the properties of heart rate variability (HRV), especially nonlinear ones. The aim of this study is to evaluate the effect of U-shaped patterns to nonlinear properties of HRV considering the ageing.

Night-time 63 RR interval series from healthy subjects (26 males, 39 females, mean age: 40±14y) collected from the Institute of Cardiology (Warsaw, Poland) and the Medical University of Gdańsk (Poland) were analyzed. Age, sex and the properties of U-shaped patterns were extracted for each recording. Nonlinear properties of HRV were described by using Detrended Fluctuation Analysis (DFA), Multiscale Multifractal Analysis (MMA) and Sample entropy.

We found significant differences of Sample entropy ($p<0.01$) and DFA α_2 ($p<0.01$) between the RR interval series with a small (<=20, 32 pts) and a large (>20, 33 pts) number of U-shaped patterns during the night. In turn, we observed significant difference of DFA α_1 between the patients <39y (32 pts.) and >=39y (33 pts.) ($p<0.01$) but no significant differences for the other nonlinear parameters. We also found the U-shaped patterns as the factor modulating the values of scaling exponents for wide range of scales (independently from the age) and the shape of Hurst surface (MMA).

The effect of the U-shaped patterns on HRV appears to be much stronger than expected judging by their total length compared to the length of the signal. These observations shed a new light on the interpretation nonlinear methods such as DFA and MMA and should be taken account in the future analysis of HRV.