A New Parameter in the Nonlinear Dynamics of the Heart: The Higher Reconstruction Step

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Nonlinear dynamics has been playing an outstanding role in the study of heart in the last decades. It not just helped our understanding of the cardiac system but also brought many parameters that improved the diagnostic methods, as the Correlation Dimension or Lyapunov Exponents. In this work we propose a new of these parameters, The Higher Reconstruction Step (HRS), an extension of the Time Lag obtained from the Autocorrelation Function (ACF) in order to reconstruct the possible chaotic attractor that lies behind the dynamics. It is computed as usual, looking for the time lag in an ACF, but the difference is that it is calculated many times, increasing the number of points in the data set used until the whole time series is swept. As the data set used is increased, new time lags are found, forming a new sequence. The HRS is just the biggest of them, for each time series. In order to verify if the HRS parameter is or is not a good one to help the doctor or the researcher to discriminate between states (its potential diagnostic use), we collected R-R time series from two groups of men: one group with a cardiac chagasic disease (24 individuals) and a second one of healthy people (21 individuals). The series, for each individual, were collected in two positions: supine and after passive 70 degree head-up tilting, with volunteers seated in a saddle (dismissing the initial transient changes). Typical values of HRS are in the range 1-5, but there are some outliers. After removing the outliers greater than 50 the HRS is significantly smaller in the healthy group, with $p < 0.01$ in a t-test for the supine position. The same result happens if we remove the outliers greater than

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