Quantitative Analysis of the Relationship Between Chaotic Features of Surface ECG and an Intracardiac Electrogram

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Analysis of electrocardiogram (ECG) signal has recently become a popular non-invasive procedure to monitor the Heart activity and Heart diseases. The aim of research was to find formulas calculating chaotic features of intracardiac electrogram (EGM) using those of surface ECG. Since chaotic features of both surface ECG and EGM carry information using diagnosis, it seems finding a relation between them would be possible. This eliminates the risk of invasive procedure of EGM recording, reduces psychological stress of patients and is cost effective. An Intracardiac Atrial Fibrillation database from Physionet (IAFDB) which consists of endocardial recordings from the right atria of patients in Atrial Fibrillation (AF) was studied. A decapolar catheter was placed in four separate regions of the heart. In each region, the 5 bipolar signals were recorded (altogether 20 intracardiac signals) with 3 surface ECG leads. Open Tstool toolbox in Matlab 7.5B software was used to extract chaotic features (correlation dimension (CD), Large Lyapunov Exponent (LLE), Spatial Feeling Index (SFI)) of the signals. Coefficients of a linear formula between the features of ECG and EGM were computed for each region (bipolar) by PLS Regression method. Independent variables of this formula were chaotic features of the surface ECG and dependent variables were chaotic features of EGM. In addition, cross validation method was applied to check validation of these formulas. Using 3 ECG Leads, for each chaotic feature of 20 Heart regions a linear formula was obtained. Obtained regression formulas based on CD feature is valid with probability value (Pval) < 0.05 and Mean Square Error (MSE) <0.5. for LLE and SFI features, the regression formulas are not valid (Pval > 0.05). Moreover, it led to an important discovery, the closer bipolar electrodes were to the heart apex, the greater coefficients of lead II would be. The aim of this study was to find formulas estimating CD, LLE and SFI of intracardiac electrogram (EGM) using those of surface ECG. Formulas acquired for estimating CD of EGM using that of ECG surface in AF patients were efficient, while efforts to obtain LLE and SFI did not yield significant results.