Predicting Effectiveness of Cardiac Resynchronization Therapy Based on the Analysis of QRS Components using the Meyer Orthogonal Wavelet Transformation

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Introduction: Cardiac Resynchronization Therapy (CRT) has shown clinical benefit for patients with heart failure. However, 20% to 30% of patients do not response to CRT. We investigated whether QRS morphology of cardiac patients prior to CRT could predict the level of response of patients to CRT. We used data from the MADIT-CRT study and developed a method to decompose time-frequency features of the QRS complex to identify characteristics common to CRT responders and non-responders.

Methods: The study evaluated 12-lead ECG recordings obtained from Fifty-eight CRT recipients (mean age = 65 $\pm$ 11 years, 41 male and 17 female) with left bundle branch block (LBBB) before CRT. The digital ECGs had 1000 Hz sampling frequency and 16-bit amplitude resolution. We developed a signal averaging algorithm to produce a representative of QRS complex (avQRS), the number of cardiac beats used for the avQRS was set in order to reach a noise level of 0.5 microvolt. Then, a Meyer orthogonal wavelet transformation was applied on the avQRS signal Thirty-four wavelet coefficients located inside the QRS were analyzed corresponding to time frequency range equal to 8-125 Hz from the onset of the QRS to 150 ms after. We compared the distribution of energies across the transformation between the two groups to identified time-frequency cells discriminating responder from non-responder to CRT.

Results: Nonparametric two-sample tests were performed on the measured thirty-four coefficients from each of three Frank orthogonal leads. The tests showed that two coefficients from lead X and three coefficients from lead Z were significantly different ($P < 0.05$) between responder and non-responder. No coefficient from lead Y shows significantly different. Receiver Operating Characteristic (ROC) curve analysis of these coefficients analysis of these parameters provided levels of sensitivity and specificity equal to 64%-72% in lead X and 64%-73% in lead Z, respectively. The level of sensitivity and specificity using QRS duration was 59% and 47%.

Discussion/conclusion: We studied the baseline surface ECG in LBBB patients with narrow QRS interval (QRS $<$ 150 ms before CRT). The time-frequency analysis of the surface ECG permitted to distinguish the CRT responder and non-responder.