Atrial Electrical Activity Detection Using Linear Combination of 12-Lead ECG Signals

ECG analysis is the method for cardiac arrhythmia diagnosis. During the diagnostic process many features should be taken into consideration, such as regularity and atrial activity. Since in some arrhythmias, the atrial electrical activity (AEA) waves are hidden in other waves, and a precise classification from surface ECG is inapplicable, a confirmation diagnosis is usually performed during an invasive procedure. In this paper, we study a “semiautomatic” method for AEA-waves detection using a linear combination of 12-lead ECG signals. This method's objective is to be applicable to a variety of arrhythmias with emphasis given to detect concealed AEA waves. It includes two variations—using maximum energy ratio and a synthetic AEA signal. In the former variation, an energy ratio-based cost function is created and maximized using the gradient ascent method. The latter variation adapted the linear combiner method, when applied on a synthetic signal, combined with surface ECG leads. A study was performed evaluating the AEA-waves detection from 63 patients (nine training, 54 validation) presenting eight arrhythmia types. Averaged sensitivity of 92.21% and averaged precision of 92.08% were achieved compared to the definite diagnosis. In conclusion, the presented method may lead to early and accurate detection of arrhythmias, which will result in a better oriented treatment.