Application of the Wavelet Based Denoising Methods for T-Wave Alternans Analysis in High Resolution ECG Maps

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Abstract. *T-wave alternans (TWA) allows for identification of patients at an increased risk for ventricular arrhythmia. Stress test, which increase heart rate, is used for TWA measurement. The TWA analysis is often disturbed by muscular interference. The evaluation of wavelet based denoising methods was performed to find optimal algorithm for TWA analysis.*

Keywords: T-wave alternans, wavelet denoising, stress test, arrhythmia, sudden cardiac death

1. Introduction

Sudden cardiac death (SCD) is the leading cause of cardiovascular mortality in developed countries [1]. The efforts of many medical scientists and physicians are concentrated on the prediction and the prevention of SCD by different diagnostic tools and therapies. At present, there is no generally accepted non-invasive risk index of SCD. T-wave Alternans (TWA) is a very promising marker of the vulnerability to ventricular arrhythmia [2]. It is defined as a beat-to-beat change in the T-wave amplitude that repeats every other heart beat and indicates the spatial heterogenity of the ventricular repolarization. Both temporal and spatial distribution of the electrical potentials generated by heart on the surface of the body could be investigated by high resolution Body Surface Potential Mapping (BSPM) [3]. In the presented study the results of the TWA assessment by using FFT-based method are shown [4]. Patients were examined with use of electrocardiographic stress test.

The aim of the study was to evaluate T-wave altemans amplitude in the BSPM signals denoised with use of different wavelet functions [5].

2. Subject and Methods

The study group consisted of 12 patients with myocardial ischemia (7 with detected TWA). Two minute ECG maps (67 channels) were recorded during stress test performed on supine ergometer (heart rate 100 bpm ± 5). The Fast Wavelet Transform [6] was applied and soft tresholding procedure was used [7]. For the final analysis 3 wavelets functions were chosen: Daubechies 1 level 6, Symlet 3 levels 4 and 5 and Symlet 8 levels 4 and 5.

3. Results

Wavelet function Daubechies 1 level 6 (db1lev6) was found to be the best for denoising ECG signals for TWA analysis. The average value of TWA magnitude calculated in denoised signals was 25% greater than in raw data with detectable TWA. The difference between TWA magnitude calculated in signals denoised with use of the db1lev6 method and another methods was 2% (SD = 3) which is not significant. The main advantage of using db1lev6 method is that the number of leads, where diagnostic significant value of TWA was found, was 30% greater than in raw data. In signals where another denoising methods were used the

increase was 10% (SD=35). There are no significant difference between TWA magnitude calculated in signals without detectable TWA before and after denoisng (0.3%, SD = 0.04).

4. Conclusion

The wavelet denoising with application of Daubechies function increases probability of TWA detection. It is directly connected with the higher TWA magnitude as well as with greater number of ECG leads where the TWA shows significant diagnostic value.

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