WAVE-FORM ANALYSIS OF ELECTROCARDIOGRAPH WITH SPECTRUM FOR SCREENING TEST

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INTRODUCTION

Electrocardiogram (ECG) reflects the conduction of action potential in the heart. ECG consists of several elements of electronic events in the heart. ECG was widely used for diagnostics of the heart disease as a noninvasive marker. To get enough information directly from the ECG tracings, enough training is necessary for an interpreter. Several computer-aided methods (Arthur, R.M. (1995), Kinoshita, O. (1992)) including R-R interval detection have been designed in the previous studies. To extend its use to the health-care device at home, a simple methodology with spectrum analysis to distinguish irregular conduction from normal one was investigated in this study.

METHODS

The electrocardiogram (ECG) was induced between the left ankle and the right wrist. The electrodes of disk type (diameter of 8 mm) were stuck via conductive gel on the surface near the joint-pivot to minimize intermixture of the electromyogram. After the signal was modified so that the frequencies lower than 0.08 Hz or higher than 1 kHz were cut off through the electric filter, it was converted into digital signal with the sampling rate of 256 Hz, and recorded with a personal computer. The segmented ECG data of one second between P wave and T wave were analyzed with fast Fourier transform (FFT). Data at the base line of ECG were added before P wave, when the cyclic period was shorter than one second.

Normal 30 segments of regular signal were collected from five volunteer human subjects between 21 and 25 years old at rest. Some segments of irregular signal were picked up from these measurements, and the data with compensatory ventricular premature contraction or with interpolated ventricular premature contraction were analyzed.

RESULTS AND DISCUSSION

The ECG spectrum decreases from 20 Hz to 40 Hz. The ECG spectrum can be represented with the range from 1 Hz to 60 Hz.

The data were displayed in the three-dimensional figure, when the interval of analysis was extended gradually from P wave to T wave with a step of 0.04 s. The spectrum at the time of one second shows datum at the whole cardiac cycle.

In the data from a normal ECG, the spectrum was distributed between 1 and 10 Hz during P-Q interval, while it was distributed 1 Hz and 40 Hz in the whole cardiac cycle. This is because the steepest wave occurs in QRS complex.

In the data both with compensatory ventricular premature contraction and with interpolated ventricular premature contraction, the spectrum significantly decreased between 20 Hz and 40 Hz. This is because of the extension of QRS wave width. Timing of irregular wave in the cardiac cycle did not affect the spectrum distribution.

The R-R interval analysis is useful to detect arrhythmia but is not useful to detect wave modification in a pre-excitation syndrome. The proposed method has enough availability to detect ECG wave change in heart disease, and can be applied to screening test in diagnosis for ventricular premature contraction.

SUMMARY

This paper proposes a simplified methodology to detect irregular conduction of potentials in heart during cardiac cycle using spectrum analysis of electrocardiogram.

REFERENCES

Arthur, R.M., Kavesh, N.G., et al (1995). *IEEE Trans Biomed Eng*, **42**, 29-41
Kinoshita, O., Kamakura, S. et al (1992). *Circulation*, **85**(6), 2054-2059.

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