Cardiac Autonomic Functions Derived from Short-term Heart Rate Variability Recordings Associated with Indeterminate Results of Treadmill Exercise Test

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INTRODUCTION

Heart rate variability (HRV) represents one of the most promising quantitative measures of autonomic activity. HRV in time and frequency domains is a noninvasive, convenient tool for evaluation of autonomic nervous physiology. Time-domain analysis estimates the variation of all differences between consecutive R-R intervals through indexes derived by statistical methods, whereas frequency-domain analysis estimates respiratory-dependent high frequency and low frequency power through spectral analysis. High frequency power is considered as mediated mainly by vagal activity, while low frequency power has been suggested as predominantly sympathetic modulation. The most commonly used time-domain indexes include SDNN, the standard deviation of the normal-to-normal interval, RMSSD, the square root of the mean squared differences of successive normal-to-normal intervals, NNI50 count, the number of intervals differences of successive normal-to-normal intervals greater than 50 ms, and pNN50, the proportion derived by dividing NNI50 count by the total number of normal-to-normal intervals. The most commonly used frequency-domain indexes include LF, low frequency power; HF, high frequency power; and total power. Short-term (5 min) recording is reliable tool to obtain HRV measures.

Current clinical practice guidelines recommend the use of the most frequent noninvasive modalities used to assess patients with suspected or proven cardiovascular disease. The electrocardiogram is used in many clinical situations to evaluate HRV, but it is limited in many situations due to the limitations of HRV measurement techniques such as metabolic gas analysis, radioluclid imaging, and electrocardiography. For the purpose of this document, exercise HRV testing will be discussed in the context of monitoring HRV during and immediately after treadmill exercise. Heart rate variability testing is a valid method for assessing autonomic nervous system function. It is widely used and is relatively low cost. The interpretation of the results requires consideration of methodological and pharmacological factors. Exercise HRV testing can be used to evaluate the effects of exercise on heart rate variability and to monitor the effects of interventions on heart rate variability.

RESULTS

Among 459 patients, 44 individuals (9.7%, 20 men) were included in the study. The clinical characteristics of the subjects were as follows: age 63.1 ± 14.4 years, 21 men, 23 women, body mass index 26.4 ± 3.3 kg/m², systolic blood pressure 147.9 ± 17.2 mm Hg, and diastolic blood pressure 85.4 ± 10.6 mm Hg. The patients were divided into three groups based on the results of treadmill exercise test: Group I (n = 26), Group II (n = 22), and Group III (n = 23). The results of treadmill exercise test were as follows: Group I, 16.5 ± 3.3 minutes; Group II, 12.3 ± 3.1 minutes; Group III, 9.8 ± 2.7 minutes. The results of treadmill exercise test were significantly different between the three groups (p < 0.05).

Comparison with indeterminate group and negative group

The indeterminate group had a higher age (56.7 ± 11.3 years, p = 0.01) and body mass index (25.4 ± 3.8 kg/m², p = 0.001) compared to the negative group. The results of treadmill exercise test were as follows: Group I, 16.5 ± 3.3 minutes; Group II, 12.3 ± 3.1 minutes; Group III, 9.8 ± 2.7 minutes. The results of treadmill exercise test were significantly different between the three groups (p < 0.05).

Comparison with positive group and negative group

The positive group had a higher body mass index (28.0 ± 4.0 kg/m², p = 0.001) compared to the negative group. The results of treadmill exercise test were as follows: Group I, 16.5 ± 3.3 minutes; Group II, 12.3 ± 3.1 minutes; Group III, 9.8 ± 2.7 minutes. The results of treadmill exercise test were significantly different between the three groups (p < 0.05).

CONCLUSIONS

Cardiac autonomic function derived from short-term heart rate variability recordings is an independent indicator of indeterminate results of treadmill exercise test.

METHODS

Study population: The study cohort consisted of 459 consecutive patients (273 men, age 54.1 ± 12.0 years) who received a symptom-limited treadmill exercise testing combined with a short-term (5 min) HRV examination for evaluation of suspected coronary artery disease. Patients with previous myocardial infarction, cardiac arrhythmias, cardiac pacemakers or implantable defibrillators, systemic or pulmonary vascular disease, history of myocardial infarction, ventricular tachycardia, or atrial fibrillation were excluded. All patients were included in the study. The results of treadmill exercise test were as follows: Group I, 16.5 ± 3.3 minutes; Group II, 12.3 ± 3.1 minutes; Group III, 9.8 ± 2.7 minutes. The results of treadmill exercise test were significantly different between the three groups (p < 0.05).

Short-term (5 min) heart rate variability recordings

Before any testing, all measurements (including blood pressure, heart rate, and body mass index) were made with the patient in a quiet. 20 min in a quiet, temperature-controlled laboratory at 26 °C. The distribution of the Cholesky method (HRV analysis software developed by the Department of Cardiology, National Cheng Kung University Hospital) was used for all transformations and analyses. The total recording time was 5 minutes.