Heart Rate Recovery With Exercise Testing

Monday, March 31, 2003, 9:00 a.m.-11:00 a.m.
McCormick Place, Hall A
Presentation Hour: 10:00 a.m.-11:00 a.m.

The heart rate recovery may be influenced by the ischemic preconditioning.

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Introduction: The warm-up phenomenon, observed after the second of two sequential exercise tests, is characterized by an increased of both time to ischemia and ischemic threshold, and the last one is probably related to an ischemic preconditioning. In the other hand, the heart-rate recovery immediately after exercise, which may be a reflection of decreased vascular activity, is a powerful predictor of overall mortality. This study aimed to investigate the effects of ischemic preconditioning on the heart-rate recovery during the first and second minutes after exercise.

Methods: Twenty patients with chronic stable angina pectoris were enrolled and all were off treatment. They underwent two consecutive treadmill exercise tests according to the Bruce protocol with recovery period between the tests of 30 min to re-establish baseline conditions. The value for the recovery of heart rate was defined as the reduction in the heart rate from the peak exercise to the heart rate one minute after the cessation of exercise.

Results: The heart rate and the heart rate pressure product at 1.0 mm ST segment depression significantly increased during the second exercise test compared to the first (121.3 ± 16.5 vs. 127.3 ± 15.3 beats/min, p < 0.001, and 216.7 ± 43.1 vs. 232.1 ± 43.0 beats/min, p < 0.001). The time to 1.0 mm ST segment depression during the second exercise test was greater than that during the first test, too (122.5 ± 112.5 vs. 267 ± 122.3, p < 0.006). The median heart rate recovery significantly increased during the second test compared to the first (51.4 ± 15.6 vs. 45.8 ± 15.7 beats/min, p < 0.05).

Conclusion: The main findings of this study are an improvement of the ischemic threshold in the second test probably related to ischemic preconditioning and an improvement of the heart-rate recovery. Although these data confirm the existence of this phenomenon, it is clear that ischemic preconditioning represents a powerful protective phenomenon and the better heart rate recovery in the second compared to the first test may be a expression of this phenomenon.

Heart Rate Recovery and Mortality After Myocardial Revascularization

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Background: Although heart rate recovery (HRR) has been shown to predict death, its ability to identify patients likely to benefit from revascularization (REVASC) is unknown.

Methods: We enrolled HRR patients without heart failure, atrial fibrillation, or pacemaker who had treadmill nuclear or echocardiographic testing. An abnormal HRR was ≥ 12 beats per minute (bpm) for nuclear testing (n = 4766) and ≥ 18 bpm for echocardiography (n = 4903). Early REVASC was defined as occurring within 3 months. We used propensity analysis to account for baseline differences.

Results: Early REVASC occurred in 552 patients (6%), who were older (61 ± 15 years, P < 0.001), more likely to have imaging evidence of ischemia (62% vs. 11%, P < 0.001), and more likely to have an abnormal HRR (29% vs. 22%, P < 0.001). We propensity matched 526 of these patients to 526 who did not undergo REVASC based on 47 variables. During 8 years of follow-up, 245 died; early REVASC was associated with a lower risk (17% vs. 22%, hazard ratio [HR] = 0.76, 95% CI 0.59-0.97, P = 0.03). In subset analyses, the benefit of REVASC was limited to patients with ischemia and impaired functional capacity. Those who also had an abnormal HRR were at very high risk and did not appear to benefit from REVASC, while those who had a normal HRR did have a lower risk of death (Figure) (adjusted HR = 0.38, 95% CI 0.20-0.73, P = 0.003).

Conclusion: When used in conjunction with ischemia and functional capacity, HRR may be able to identify patients likely to benefit from revascularization.

Novel Heart Rate Recovery Constant Predicts the Presence and Severity of Coronary Artery Disease

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Background: Heart rate recovery (HRR) has been shown to be important in predicting the prognosis of patients after exercise treadmill testing. To our knowledge, HRR has not been shown to predict the presence of coronary artery disease (CAD).

Purpose: To test a novel formula describing HRR at any point in time that yields a constant that allows for a better description of HRR and may predict the presence and severity of CAD.

Methods: Using the formula:

\[ k = \ln\left(\frac{HR_{\text{resting}} - HR_{\text{max}}}{HR_{\text{max}} - HR_{\text{resting}}}\right) / [-\text{time (sec)}] \]

the k-values were calculated at 1, 2, 3, and 5 minutes after exercise. The k-values were then averaged and compared to the angiographic results of patients undergoing exercise testing.

Results: Of the 850 patients, 480 had significant CAD. Patients with CAD had an average k-value of 0.0084, which was significantly greater from patients without disease (average k-value = 0.0072, p-value = 0.0087). The k-value was also able to predict long-term prognosis (10 year survival; high risk, 69%, other groups, 77%, p-value = 0.05).

Conclusion: This confirms the potential of the k-value constant to help predict the presence and severity of CAD in patients undergoing exercise treadmill testing.

Timing of Heart Rate Decay After Exercise and Mortality

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Background: Heart rate recovery (HRR) is defined as the difference between peak heart rate and heart rate one minute later. It has been shown to predict prognosis. However, the timing of heart rate decay has not been well-studied.

Methods: We followed for 6 years 1,264 patients (age 51 ± 14 years) who underwent treadmill testing followed by a 2-minute cool-down period and had HR recorded by computer every 10 seconds. HR decay, at each point in time t was defined as HR decay = HR. The slope of the logarithm of this value, that is, \( \log(\text{HR}_t) \), was used to describe the pattern of heart rate decay (Figure).