Thesis Title	Cardiovascular Autonomic Function Tests in Thai Normal Subjects
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Abstract

Cardiovascular autonomic function tests are simple, non-invasive procedures, based on cardiovascular reflexes, for evaluating the autonomic control of the circulation and the autonomic nervous system in general. These consist of three heart rate (HR) tests, i.e., postural HR response (30:15 ratio), deep breathing (max-min HR), and Valsalva maneuver (Valsalva ratio); and two blood pressure (BP) tests, i.e. postural BP change (change in systolic BP), and sustained handgrip (rise in diastolic BP). For meaningful interpretation of the tests in patients, normal values must be established in the population studied, and this had not been done in Thais. Moreover, in a preliminary study, sustained handgrip test using standard handgrip dynamometer yielded test results lower than previously reported, which may be due to the instrument used. Therefore, a more appropriate test or procedure was needed. The objectives of this study were (1) to establish normal value for cardiovascular autonomic function tests in Thais; (2) to study the factors affecting the cardiovascular autonomic function and their interrelation; and (3) to find a test that could replace the handgrip exercise test using handgrip dynamometer.

The five tests were performed in 114 healthy subjects (age 18-79 years, 66 women and 48 men). Normal values were those $\geq P_{10.0}$; abnormal values were those $< P_{2.5}$; the values between these two limits were considered borderline. Data which were not normally distributed were logarithmically transformed. In addition, age-related normal values were determined for all three heart rate tests, using the same criteria as above. The average values for each tests were: The postural BP response,

-0.4 ± 6.6 mmHg; postural HR response, 1.28 ± 0.18; deep breathing test, 21.8 ± 8.6 beats/min; Valsalva ratio, 1.53 ± 0.33; and sustained handgrip response, 27.2 ± 9.2 mmHg for men and 20.8 ± 7.5 mmHg for women.

Pearson's correlation coefficients were determined for each test result and the following factors: age, body mass index (BMI), hemoglobin concentration (Hb), resting heart rate (RHR), systolic and diastolic BP, mean arterial blood pressure (MABP), pulse pressure (PP), and maximum voluntary contraction (MVC). In addition, unpaired t-test and Mann-Whitney U test was used to compare test results between men vs women, alcohol drinkers vs non-drinkers, and smokers vs non-smokers. Stepwise multiple regression was used to determined the independent factor for each tests. The result showed that age was the most important factor influencing postural BP change ($r = 0.23$, $R^2 = 5\%$), postural HR response ($r = -0.56$, $R^2 = 31\%$); deep breathing ($r = -0.62$, $R^2 = 39\%$), and Valsalva ratio ($r = -0.41$, $R^2 = 17\%$, all p's were < 0.05). There were some other factors influencing these test results, e.g. BMI was correlated with all the four tests, but these other factors were all dependent on age. MVC was the most important factor, as determined by stepwise multiple regression, influencing sustained handgrip response ($r = 0.44$, $R^2 = 19\%$, $p < 0.05$). The cardiovascular autonomic function test results was not influenced by gender, except the sustained handgrip response with greater response in men than in women because of men's larger MVC ($p < 0.0001$). There was not difference in the cardiovascular autonomic function test results between alcohol drinkers vs non-drinkers, and between smokers vs non-smokers.

Two methods of sustained handgrip test were compared: 1) using standard handgrip dynamometer and 2) using inflated, rolled sphygmomanometer cuff (pre-inflated to 100 mmHg). The latter method gave a greater rise in diastolic BP than the former, due to the absence of instantaneous reading in the former method. Therefore, inflated-rolled arm cuff should be used in place of the handgrip dynamometer as a standard procedure. Cold pressor test was another method of assessing sympathetic efferent, as does sustained handgrip test, but this test caused too much discomfort to be used routinely or replace sustained handgrip test.