BAROREFLEX SENSITIVITY IN PATIENTS WITH CHRONIC CORONARY ARTERY DISEASE: INFLUENCE OF EIGHT WEEK’S EXERCISE TRAINING

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Abstract

Low baroreflex sensitivity (BRS) is a marker of increased risk of sudden cardiac death in patients after myocardial infarction. The present study was designed to evaluate whether a specific program of eight week’s exercise training at anaerobic threshold level may be sufficient to improve BRS in patients with chronic coronary disease. Twenty patients with chronic coronary artery disease were selected on the basis of cardiographic, coronarographic and NYHA evaluation (I-II). Symptom-limited spiroergometry was carried out before and after the training. BRS was determined by spectral analysis of the pulse interval and systolic blood pressure. It is concluded that 8 weeks of exercise training at anaerobic threshold level was sufficient to improve BRS in patients with chronic coronary disease.

Key words
Chronic heart disease, 8-week exercise training, Cardiopulmonary functions, Baroreflex sensitivity

INTRODUCTION

Sympathetic overactivity associated with low parasympathetic activity is an autonomic dysfunction which increases cardiac mortality (1). Heart rate variability and baroreflex sensitivity are the values which reflect the autonomic dysfunction (2, 3, 4, 5). In patients with essential hypertension, low heart rate variability and BRS are present, both being markers of increased sympathetic activity (6, 7, 8, 9, 10, 11). Low baroreflex sensitivity (BRS) is a marker for an increased risk of sudden cardiac death in patients after myocardial infarction (12, 13). The present study was designed to evaluate whether a specific programme of exercise training at an anaerobic threshold level may be sufficient to improve cardiopulmonary functions and BRS of patients with chronic coronary disease (CCD).
MATERIALS AND METHODS

Patients
Twenty patients (body weight, 86±6 kg; body height, 17±6 cm; age, 63±8 years) with chronic coronary artery disease were selected according to the inclusion criteria listed below. Their diagnosis was established using single-photon emission computed tomography (SPECT), stress echocardiography (ECG record of ischaemia during exercise testing) and coronaryography and on the basis of the NYHA classification (I-II). Medical regimens of all the selected patients were optimised to ensure that the patients were symptomatically stable Standardised medical treatment at the beginning and the end of the 8-week period included administration of angiotensin converting enzyme inhibitors, diuretics, nitrates and digitalis in varying combinations.

Criteria for inclusion: Presence of at least one coronary stenosis of more than 50% of the lumen diameter. Objective evidence of ischaemia (positive SPECT or positive ECG response during exercise testing). Patient’s informed consent.

The study included patients who had undergone both cardiopulmonary exercise testing and echocardiography on two occasions separated by an interval of 8 weeks.

For assessment of autonomic function as a measure of baroreflex sensitivity (BRS) related to ageing, we included a group of healthy subjects (n=15) matched by sex, age, body weight and height (64±8 years; 84±6 kg; 173±7 cm).

Experimental procedure
The symptom-limited spiroergometry was provided before and after the training. We evaluated the maximal attained workload Wmax, (W), peak oxygen consumption (VO2, ml.min⁻¹); peak VO2. kg⁻¹ body weight; maximal consumption of oxygen expressed in metabolic units (MET).

Training period
Prior to the training course, spiroergometry was used to assess the anaerobic threshold for the determination of intensity of training in each individual. The training was provided in the Department of Functional Diagnostics and Rehabilitation three times a week and consisted of a 15-minute warm-up phase of individual exercises followed by 30 minutes of cycling, with the individual anaerobic threshold workload, and ending with the patients having a cool-down phase of 15 min.

Echocardiography
Echographic measurements of left ventricular function and the ejection fraction (EF) were carried out before and after the training period, using Hewlett-Packard, SONOS 2000 (USA) echocardiographic equipment.

Baroreflex sensitivity
BRS (ms.mmHg⁻¹) was determined by spectral analysis of the pulse interval (PI, ms) and systolic blood pressure (SBP, mmHg). The blood pressure was recorded for 5 min of beat-to-beat, non-invasive monitoring in the sitting position (Finapres Ohmeda [14]) during metronome-controlled breathing at a frequency of 0.3 Hz) before and after the training (15). In the control group, only one measurement of BRS was taken under resting conditions.

The study was approved by the Ethics Committee of Masaryk University in Brno and all subjects gave their written informed consent.

The results, expressed as mean±SD, were statistically evaluated with the use of ANOVA and Wilcoxon tests; P values < 0.05 were considered significant.
RESULTS

The results of PI, SBP, BRS $W_{max}$, peak VO$_2$ and MET values before (B) and after (A) the training are given in Tables 1 and 2. In the patients (P), there were significant differences in $W_{max}$ values between the measurements at the beginning and the end of the 8-week period of training (Table 1). A significant increase in resting PI and in BRS values ($P<0.05$) was found in the patients at the end, as compared with the beginning of training. The PI values in the patients after training (PA) were almost the same as in the control group (C), while the BRS values did not achieve the levels of healthy subjects (C).

Our results show that, in the patients with coronary artery disease, eight weeks of exercise training at the anaerobic threshold level produced an increase in pulse interval, baroreflex sensitivity and in the maximal attained workload.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Wmax</th>
<th>VO2</th>
<th>MET</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB</td>
<td>142±31</td>
<td>20±4</td>
<td>6.2±1</td>
</tr>
<tr>
<td>PA</td>
<td>156±32*</td>
<td>21±3</td>
<td>6.4±1</td>
</tr>
</tbody>
</table>

*, significant difference between PB and PA ($P<0.05$).

Table 2

<table>
<thead>
<tr>
<th></th>
<th>PI</th>
<th>SBP</th>
<th>DBP</th>
<th>BRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB</td>
<td>852±163+</td>
<td>123±19</td>
<td>66±12</td>
<td>2.9±0.9+</td>
</tr>
<tr>
<td>PA</td>
<td>926±126*</td>
<td>130±16</td>
<td>67±9</td>
<td>3.9±1.1*x</td>
</tr>
<tr>
<td>C</td>
<td>924±112</td>
<td>119±13</td>
<td>69±12</td>
<td>7.8±3.8</td>
</tr>
</tbody>
</table>

DBP, diastolic blood pressure; *, significant differences in PI and BRS between PA and PB ($P<0.05$); +, significant differences between PB and C ($P<0.05$); x, significant difference between PA and C ($P<0.05$).
The assessment of baroreflex sensitivity was introduced to clinical practice by Smyth, Sleight and Pickering in 1969 (cited by 7). These authors reported that intravenous administration of phenylephrine induces an increase in blood pressure and, as a reaction to it, there is a decrease in the heart rate. Baroreflex sensitivity is then expressed as an extension of the pulse interval (in ms) related to a rise in systolic blood pressure (per mmHg). Baroreflex heart rate sensitivity is low in patients with essential hypertension. This fact has been demonstrated by the classical phenylephrine method (7) and by a spectral method (6, 8). The mean value of BRS in hypertensives is about one half of that in normotensives.

Impaired (decreased) baroreflex sensitivity is an indicator of increased risk of sudden cardiac death in patients after myocardial infarction. Myocardial infarction acutely reduces BRS that, however, may recover and return to normal values within 3 months (16), but not as a rule. Heart damage generally results in an increase in efferent sympathetic nervous activity. BRS is inversely related to potential ventricular fibrillation during experimental myocardial ischaemia (17). A low value of BRS is associated with increased mortality (18). There are other measures of cardiac damage, such as decreased heart rate variability, low ejection fraction, ventricular premature beats, blood pressure reduction, altered breathing patterns, elevated concentrations of cardiac enzyme and plasma norepinephrine, and a reduction in urine volume and urine sodium levels associated with a rise in plasma creatinine. In order to have any prognostic value, these criteria, which are more simple than BRS measuring, need coordination with BRS measurements. Bigger et al. (18) suggested that the relative utility of measurements of heart rate variability and of BRS for prediction of sudden cardiac death “needs to be evaluated in a large prospective study”. The “ATRAMI“ study has shown the way to a more precise determination of the best prognostic indices to guide therapy (19).

In view of the facts stated above, the possible increase in BRS following our 8-week training course is important in terms of prognosis for patients with chronic artery disease.


BAROREFLEXNÍ SENZITIVITA U PACIENTŮ S CHRONICKÝM ONEMOCNĚNÍM KORONÁRNÍCH TEPEN: VLIV 8-TÝDenního TRÉNINKU

S o u h r n

Nízká baroreflexní sensitivita (BRS) je znakem zvýšeného rizika výskytu náhlé srdeční smrti u pacientů s infarktem myokardu. Tato studie měla posoudit, zda specifický program 8-týdenního rehabilitačního tréninku na úrovni anerobního prahu může být dostatečný pro zlepšení BRS u pacientů s chronickou ischemickou chorobou srdeční. Výsledky jsme 20 nemocných s chronickou ischemickou chorobou srdeční (kardiografie, koronarografie, NYHA I-II, stabilní léčba, hmotnost


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86±16 kg, věk 63±8 let). Symptomy limitovaná spiroergometrie byla provedena před tréninkem a po něm. BRS byla stanovena spektrální analýzou pulzového intervalu a systolického krevního tlaku. Z našich výsledků uzavíráme, že 8-týdenní rehabilitační trénink na úrovni anerobního prahu byl dostatečný pro zlepšení BRS u pacientů s chronickou ischemickou chorobou srdeční.

Acknowledgements

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REFERENCES
