EFFECT OF EXERCISE ON RATE PRESSURE PRODUCT IN PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN WITH CORONARY ARTERY DISEASE

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Abstract : Incidence of coronary artery disease (CAD) increases sharply after menopause in women. Rate pressure product (RPP) is a major determinant of cardiac oxygen consumption. It is an important indicator of ventricular function. RPP varies with exercise. The peak rate pressure product (PRPP) which gives an accurate reflection of the myocardial oxygen demand and myocardial workload is the RPP at peak of exercise. The higher the PRPP, the more will be myocardial oxygen consumption (MVO_2). The ability to reach higher PRPP is associated with more adequate coronary perfusion. Thus the low value of PRPP suggests significant compromise of coronary perfusion and decreased left ventricular function. In the present study effect of exercise on RPP of pre and postmenopausal women with CAD was compared. The percentage increase in RPP was significantly more in postmenopausal women with CAD (62%) as compared to premenopausal women with CAD (54%) indicating more compromised coronary perfusion in postmenopausal women.

Key words : coronary artery disease   rate pressure product
           premenopausal   postmenopausal   exercise

INTRODUCTION

Coronary artery disease (CAD) results from imbalance between oxygen supply and demand of the heart and the incidence increases sharply after menopause due to fall in estrogen levels. Estrogen deficient state affects myocardial efficiency by enhancing cardiovascular response to physiology stress and by changing lipid profile (1). Moreover there is accelerated cell death in the aging myocardium leading to depletion of functional myocytes that decreases the contractile performance (2). Myocardial oxygen consumption (MVO_2) is a good indicator of the response of the coronary circulation to increased myocardial oxygen demand. The coronary blood flow (CBF) shows a linear correlation with the level of MVO_2. Thus the determinants of MVO_2 are also the determinants of CBF (3). Direct measurement of MVO_2 is difficult in routine clinical practice but it can be easily calculated by indirect methods like Stroke work, Pick's

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Principle, the tension time index and rate pressure product (RPP) (4).

RPP is the product of heart rate and systolic blood pressure [RPP = Systolic blood pressure (SBP) × heart rate (HR)/1,000] (5). It is an easily measurable index, which correlates well with MVO_2 and defines the response of the coronary circulation to myocardial metabolic demands. It is a good index of MVO_2 in-patients with ischemic heart disease (6). Rate pressure product is also called Robinson index (7). The internal myocardial work performed is represented by RPP and external myocardial work performed is generally expressed as stages of exercise (8).

There are very few reports on the effect of exercise on RPP in premenopausal and postmenopausal women with compromised coronary circulation. Hence this study was designed to evaluate the effect of exercise on RPP in premenopausal and postmenopausal women with CAD.

MATERIAL   AND   METHODS

The study was conducted in 50 volunteer women. They were divided into two groups. Group A consisted of 25 premenopausal women with CAD and Group B consisted of 25 postmenopausal women with CAD. The study protocol was approved by Institutional ethics committee. Written informed consent was taken from all the volunteers before enrollment. Exercise stress test was performed on treadmill, which is the most commonly used dynamic exercise device for this test. All the subjects were first thoroughly examined and those having any

systemic disease other than CAD were excluded. The baseline HR, SBP and ECG were recorded. SBP was measured by auscultatory method.

The subject was subjected to graded exercise according to Bruce protocol. The protocol dictates the precise speed and slope of treadmill. According to this each three-minute interval is known as a stage. The subject was made to run on a treadmill till exhaustion. At timed stages during the test, the speed (km/hr) and grade of slope (%) of the treadmill were increased. The ECG was constantly displayed on the monitor. It was also recorded on paper at one minute interval. The patient's blood pressure was recorded during the second minute of each stage.

RPP, which is the product of SBP and HR, was computed as (9) :

RPP = SBP in mm $Hg \times HR$ beats/min $\times 10^{-3}$

The maximum RPP at maximum exercise is called PRPP. The exercise test is said to be maximal when the subject appears to give true maximal effort i.e. effort done to the point of bodily exhaustion or when other clinical end points are reached. Exercise test was terminated in the subjects if the target heart rate was achieved or they complained of fatigue. Exercise was also discontinued if there were abnormal changes like decrease in SBP of 10 mm Hg along with evidence of ischaemia, abnormal ECG pattern like ST segment displacement, appearance of arrhythmias, bundle branch block or if subject complained of chest pain.

Statistical   analysis

Data was represented as mean ± standard error (SE). Analysis was done using ANOVA and Kruskal Wallis tests and P value <0.05 was considered as statistically significant.

RESULTS

The patients in Group A and Group B were comparable for demographic characteristics (Table I). The mean age of Group A was 42 years and Group B was 57 years. The Baseline SBP was significantly more in postmenopausal women as compared to premenopausal women.

TABLE I : Demographic profile of subjects at baseline in both groups.

Characteristic	Group A	Group B
Age (years)	41.7±1.2	57.2±1.2*
Weight (kg)	65.3±2.0	63.3±2.4
Height (cm)	151±4.1	155.5±1.5

*P<0.05 as compared to group A.

Table II shows changes in RPP and PRRP in both the groups. The RPP in group A increased significantly from 9.9 ± 0.4 to 27 ± 1.0 mmHg beats/mm $\times 10^{-3}$ during exercise. Group B also showed a significant increase in RPP from 10.9 ± 0.6 to 25 ± 1.0 mmHg beats/min $\times 10^{-3}$ The percentage increase in RPP was significantly more in premenopausal women (62%) as compared to postmenopausal women (54%) during exercise.

There was a significant increase in SBP and HR during exercise in both the groups.

TABLE II : Parameters at baseline, at maximum exercise and percentage change in Group A and B.

Characteristics	Baseline	Maximum	Percentage change
Heart rate			
Group A	80±3.4	150±4.7#	48
Group B	79±3.7	150±4.4#	49
SBP			
Group A	125±3.2	181±4.6#	31
Group B	139±3.2*	165±3.6*#	15*
RPP			
Group A	9.9±0.4	27±1.0#	65
Group B	10.9±0.6	25±1.0#	54*

*P<0.05 as compared to group A.
#P<0.05 as compared to baseline value.

The percentage increase in SBP was significantly more in premenopausal women as compared to postmenopausal women. There was no statistically significant difference in percentage change in HR between the groups.

DISCUSSION

Both HR and SBP are the most important variables determining changes in myocardial oxygen consumption between rest and exercise (10). HR, SBP and RPP increases with the increase workload on the heart to provide the adequate blood supply to the active myocardium during exercise.

As reported earlier also, there was significant increase in SBP, HR and RPP with exercise, due to increase in sympathetic discharge (11, 12). RPP increased progressively with exercise and attained the peak value of 27 ± 1.0 mm Hg $\times$ beats/min $\times 10^{-3}$ in premenopausal women with CAD and 25 ± 1.0 mm Hg $\times$ beats/min $\times 10^{-3}$ in postmenopausal

women with CAD. The percentage increase in RPP was significantly more in premenopausal women as compared to postmenopausal women indicating better coronary perfusion in premenopausal women with CAD. The less percentage increase in postmenopausal women with CAD suggests significant compromise of coronary perfusion and decreased left ventricular function.

Angina is precipitated due to increase in work of the myocardium as measured by RPP to a critical value that is essentially fixed in each patient. Most normal individuals develop a RPP of 20 to 35 mm Hg $\times$ beats/min $\times$ 10^{-3}. In many patients with significant ischemic heart disease RPP values exceeding 25 mm Hg $\times$ beats/min $\times$ 10^{-3} are unusual (13). In the present study PRPP was 27 and 25 mm Hg $\times$ beats/min $\times$ 10^{-3} in premenopausal and postmenopausal women with CAD respectively. The peak RPP is an accurate reflection of the myocardial O_2 demand and workload. Reaching a high RPP without symptoms or evidence of severe ischemia suggests adequate left ventricular function and the low value of PRPP suggests significant limitation of coronary perfusion and decrease left ventricular function leads to angina. Maximum RPP is reported to range from 10th percentile value of 25,000 to a 90th percentile of 40,000 (14). RPP exceeding 22 is commonly associated with myocardial ischaemia and angina (6).

Although rate pressure product does not predict regional myocardial supply demand relationships, examination of the individual components (heart rate and systolic blood pressure) is useful in management of ischaemic heart disease. An increase in blood pressure without a change in heart rate appears to be better for myocardial oxygenation than an increase in heart rate along with the increase in blood pressure (6). In our study, there was increase in HR and SBP in both the groups during exercise. The percentage increase in HR was comparable in both the groups. On the other hand, the percentage increase in SBP was significantly more in premenopuasal women as compared to postmenopausal women. Peak SBP was also significantly less in postmenopausal women as compared to premenopausal women with CAD. The decrease in peak SBP in postmenopausal women with CAD may due to age related depletion of cardiac myocytes which has been proposed as a mechanism for decreased hemodynamic and contractile performance (2, 15).

The baseline SBP was significantly more in postmenopausal women with CAD than premenopausal women with CAD. It may be attributed to increase in sympathetic discharge and vagal withdrawal due to low estrogen level (16). Menopause also increases aortic stiffness (17). Estrogen replacement therapy is reported to enhance arteriolar dispensability and ameliorate baroreceptor sensitivity, which leads to decrease SBP and RPP in post menopausal women (18).

The results of this study indicate that coronary perfusion and left ventricular functions are more compromised in postmenopausal women with CAD as compared to premenopausal women with CAD. The results also suggest that measurement of PRPP in response to physiological stress exercise can detect CAD even before the appearance of clinical signs and symptoms in women.

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