

Effect of Exercise Training on Rate Pressure Product in Ischemic Heart Disease

Abla M. Hamed* and Mohamed Mohy El Dien**

*Department of Physiotherapy for Cardiopulmonary Disorders and Their Surgery and Geriatrics, Misr University for Science and Technology.

**National Heart Institute.

ABSTRACT

Purpose: This study was conducted to investigate the effect of aerobic exercise program on rate pressure product after rehabilitation of ischemic heart disease patients. **Subjects:** Thirty male patients were selected from the out patient clinic of the National Heart Institute participated in the study. Their mean age was 55 ± 3.4 years and the mean ejection fraction was 40-45%. They suffered from hypertension and limited exercise tolerance from two years ago. **Methods:** All patients were evaluated by maximal exercise test before and after six months (24 weeks) of training. The measuring parameters included resting rate pressure product with mean 9476.78 ± 230.8 beat/min. mmHg, resting systolic blood pressure with mean 123.46 ± 13.34 mmHg and resting heart rate with mean 76.76 ± 11.06 beat/min.. All participants received aerobic training program at 40% of peak oxygen consumption in the form of cycle exercise training. **Results:** The post treatment results of the study revealed significant reduction in the rate pressure product. **Discussion and conclusion:** Aerobic exercises at 40% of peak oxygen consumption can be considered as an effective intervention in rehabilitation of ischemic heart disease patients.

INTRODUCTION

Angina pectoris is a clinical syndrome that consists of discomfort or pain in the chest, jaw, shoulder, back or arm. It is aggravated by exertion or emotional stress and relieved by rest or nitroglycerine¹³.

The relation between severity of angina pectoris and decrease blood flow to the myocardial muscles is linear relationship and subsequently with myocardial oxygen supply. Angina pectoris may be due to an imbalance between myocardial oxygen supply and myocardial oxygen demand².

Rate pressure product (RPP) is a major determinant of myocardial oxygen

consumption. It is an important indicator of ventricular function. Rate pressure product varies with exercise. Peak rate pressure product (PRPP) gives an accurate reflection of the myocardial oxygen demand and myocardial workload. 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 perfusion¹⁰.

Rate pressure product is one of the common methods used to determine the myocardial workload. It is a product of systolic blood pressure multiplied by heart rate⁵.

Exercise intensity plays a role in hemodynamic response (blood pressure and heart rate) during and after exercise³.

In patients with angina pectoris, there is a relation between the heart rate and systolic blood pressure and the onset of anginal pain. Rate pressure product is also a major determinant of myocardial oxygen consumption. In cardiac patient it is necessary not only to the decrease blood pressure but also to decrease heart rate¹².

In a light exercises, the cardiac out put is increased gradually, while at fixed sub maximal workload, steady state condition is reached and during heavy exercise, blood flow and oxygen extraction increased by three folds. However, total peripheral resistance decrease⁹.

The aim of this study was to determine the effect of aerobic exercise training program on the rate pressure product during rehabilitation of ischemic heart disease patients.

SUBJECTS, MATERIALS AND METHODS

Subjects

Thirty male patients with ischemic heart disease participated in the study. They were selected from the out patient clinic of the National Heart Institute. Their mean age was 55 ± 3.4 years; the mean weight was 75.1 ± 2.1 kilograms, the mean height was about 171 ± 2 centimeters, mean peak oxygen saturation (VO_2) was 1280 ± 236.8 ml/min., mean systolic blood pressure 123.46 ± 13.34 mmHg, mean heart rate 76.76 ± 11.06 beat/min. and the ejection fraction was between 40-45%.

All patients were examined by cardiologist to exclude any other medical conditions. The patients signed a consent for agreement to participate in the study.

Materials

For evaluation

- Medical Graphic Corporation- CAD/NET, maximal exercise test unit; was used to measure oxygen saturation (VO_2), blood pressure and heart rate during test. It consists of electro cardiogram (ECG), a screen indicating the percentage of carbon dioxide in breathes, cycle ergometer (Erg 1100).
- Digital pulse meter; was used to monitor resting heart rate and rhythm.
- Mercurial sphygmomanometer was used for resting and periodic measurement of blood pressure.

For treatment

- Cycle ergometer (Mijnhardt , St. Paul, MN): used for training program.

Methods

For evaluation

Before conducting the maximal exercise test, all participants were instructed to visit the testing places to be familiarized with the equipment and to be cooperative during conducting the test.

The patient's name, address, telephone number, height, weight, sex and age were recorded. To obtain maximum patient's confidence and performance, brief explanation of the procedures was done. Patients continued to take routine medication before exercise testing.

Patients were asked to sit in an upright position; each patient underwent a maximal cycle ergometer exercise test, with gradual increase in increments every 3 minutes until exhaustion. Oxygen consumption and carbon dioxide were measured on breath by breath basis. The heights value of VO_2 achieved during the test determined and calculated at 40%.

The recovery phase continued for about 3 minutes after the end of the test to record ECG and blood pressure values till reaching the resting values.

- From recumbent position, the systolic and diastolic blood pressure were determined by the mercurial sphygmomanometer.
- From supine lying position, the resting pulse rate, was determined for each subject individually.

Evaluation for the measuring variables was carried out before and after 6 months of treatment.

For treatment

Each patient sat on a cycle ergometer and began the exercise of 3 min. warm up, 45 min. of exercise at a work load in intensity equivalent to 40% of VO_2 peak and 2 min. of active recovery as three sessions per week for six months.

Patients were monitored for heart rate and blood pressure during each session.

RESULTS

The raw data of rate pressure product, resting systolic blood pressure and resting heart rate were statistically treated to determine the mean and standard deviation of measuring variable before and after six months of treatment. Student's t-test was then applied to examine the significance of treatment.

The pre and post treatment mean values of resting heart rate were 76.76 ± 11.06 beat/min. and 72.56 ± 7.5 beat/min., respectively ($P < 0.001$). The mean value of resting systolic blood pressure pre treatment was 123.46 ± 13.34 mmHg and post treatment was 108.86 ± 5.84 mmHg ($P < 0.001$). The mean values of rate pressure product pre and post treatment were 9476.78 ± 230.8 beat/min. mmHg and 7898.88 ± 180.98 beat/min. mmHg, respectively ($P < 0.0001$), (table 1 and figure 1,2,3).

Table (1): Showed the mean values of resting pulse rate, resting blood pressure and rate pressure product pre-treatment and post treatment.

Parameter	X±SD pre treatment	X±SD post treatment	t-value	P-value
Heart rate	76.76 ± 11.06	72.56 ± 7.5	2.69	<0.001
Systolic blood pressure	123.46 ± 13.34	108.86 ± 5.84	7.08	<0.001
Rate pressure product	9476.78 ± 230.8	7898.88 ± 180.98	10.97	<0.0001

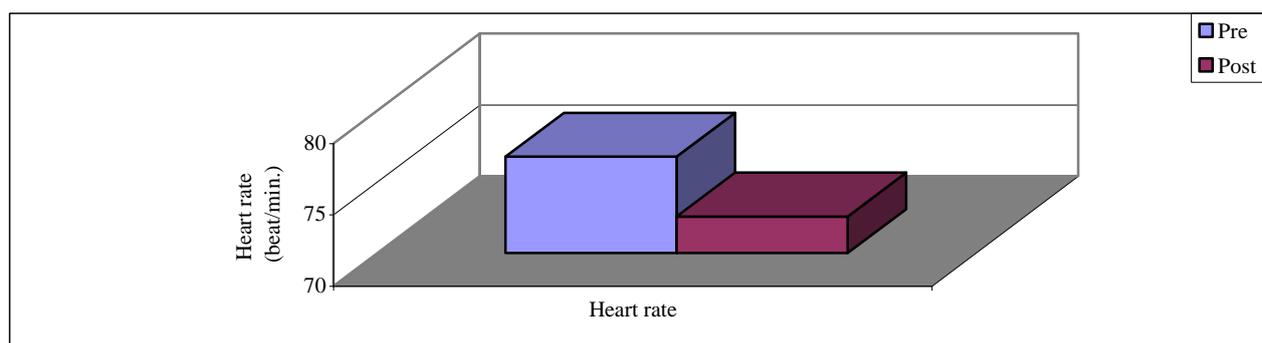


Fig. (1): Illustrates the mean values of resting heart rate (b/min) pre treatment and post treatment.

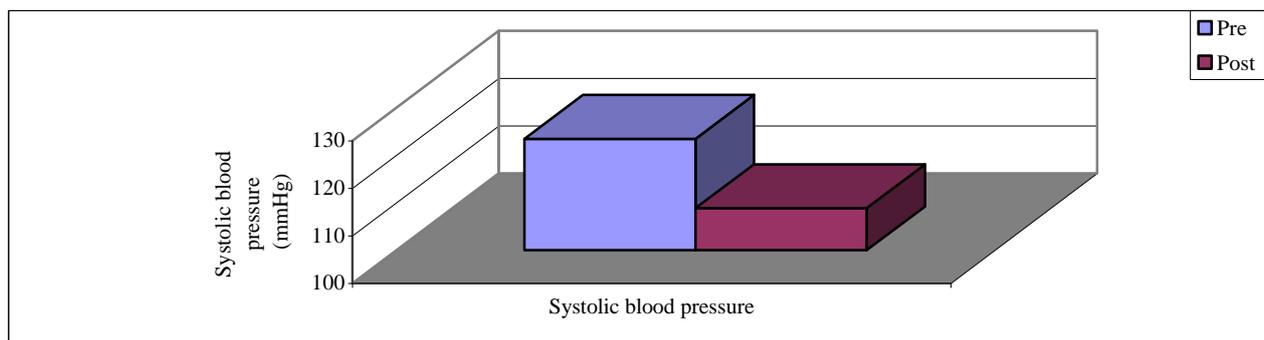


Fig. (2): Illustrates the mean values of resting systolic blood pressure (mmHg) pre treatment and post treatment.

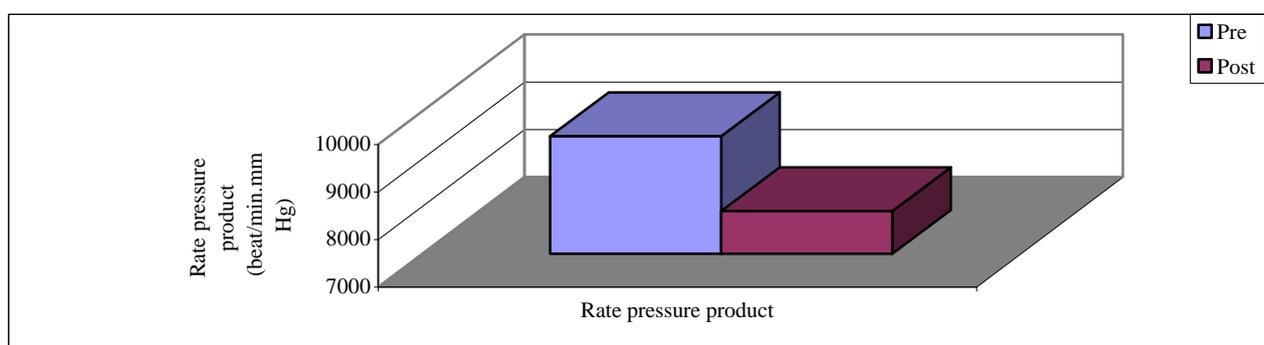


Fig. (3): Illustrates the mean values of rate pressure product (beat/ min mmHg) pre treatment and post treatment.

DISCUSSION

This study was conducted to determine the effects of aerobic training on rate pressure product.

One of the most common methods used to estimate the myocardial work load and resulting myocardial oxygen consumption is the rate pressure product. It equals systolic blood pressure multiplied by heart rate. Typical values for rate pressure product range from 6,000 under resting conditions to 4,0000 under strenuous exercises¹⁴.

Many studies mentioned the physiological correlation between rate pressure product and onset of angina pectoris. The rate pressure product is considered an objective

parameter to determine the effect of exercise on angina pectoris⁷.

The results of the current study agree with Coats¹ who concluded that, rate pressure product at sub maximal exercise reflects myocardial oxygen requirement. It was found that, reduction of rate pressure product after aerobic training results in more efficient exercise performance while, endurance training improves central hemodynamic state which was not associated with improvement in exercise capacity.

Comparing the pre and post treatment results indicated, statistical significant reduction regarding resting heart rate, resting systolic blood pressure and rate pressure product.

The post treatment results also confirm the findings of Pollock et al.,¹¹ who reported that, the rate pressure product (RPP) is lowered during mild aerobic exercise than during maximal aerobic exercise, primarily because of a lower peak heart rate response. Increased sub endocardial perfusion secondary to elevated diastolic blood pressure and decreased venous return, left ventricular diastolic volume and wall tension may also contribute to the lower incidence of ischemic responses during resistance effort.

The results of the current study come in agreement with Gibbons⁴ who mentioned that, management of patients with angina pectoris usually focused on achieving the normal physiological balance between the myocardial oxygen uptake and coronary blood flow, by decreasing myocardial oxygen uptake and to some extent increasing coronary blood flow.

The results also agree with Michael⁸ who postulated that, aerobic exercise increases cardiovascular functional capacity with no effect on left ventricular function, and it decreases myocardial oxygen demand at a given sub maximal load to be more efficient in responding to higher work load with less effort.

Howard et al.,⁶ reported that, aerobic training results in decreased oxygen demand of the heart for a given level of total body oxygen consumption. This is manifested by a decrease in the rate pressure product for a given level of exercise. Reduced oxygen demand and myocardial work are reflected on lowering heart rate and blood pressure at rest and general reduction in sympathetic tone. In addition, there is an increase in the formation of collateral arteries and reduction in the rate of progression of coronary artery atherosclerosis.

Conclusion

Aerobic exercises at 40% of maximum oxygen consumption has a positive effect on reduction of the rate pressure product and subsequently the oxygen consumption of the myocardial, leading to increase perfusion of the endocardial and increase the reserve of oxygen needed for another effort of exercise or for daily living activities.

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الملخص العربي

تأثير التدريبات الهوائية علي ناتج معدل الضغط في مرض قصور عضلة القلب

تهدف هذه الدراسة إلى تحديد تأثير التدريبات الهوائية علي ناتج معدل الضغط في مرضي قصور عضلة القلب . أجريت هذه الدراسة على ثلاثين مريضاً ممن يعانون من مرض قصور عضلة القلب وقد كان متوسط أعمارهم 55 ± 3.4 وقد اختبرت عينه الدراسة من معهد القلب القومي . تم قياس كلا من معدل ضربات القلب و ضغط الدم مع قياس ناتج معدل الضغط في الحالة الساكنة قبل وبعد فترة العلاج التي استمرت لمدة ستة أشهر. تلقت مجموعة الدراسة تدريبات هوائية في صورة تدريب علي العجلة الثابتة عند قدرة تعادل 40% من معدل استهلاك الأوكسجين . وقد أوضحت الدراسة نتائج ذات دلالة احصائية عالية في صورة انخفاض في معدل ضربات القلب وضغط الدم وكذلك ناتج معدل الضغط في الحالة الساكنة . ومن هنا يتضح أن التدريبات الهوائية لها تأثير ايجابي واضح علي انخفاض ناتج معدل الضغط المسئول أساساً عن معدل استهلاك الأوكسجين لعضلة القلب مما يعطى صورة واضحة عن زيادة نسبه احتياطي الأوكسجين لعضلة القلب ليوكب احتياج هذه العضلة مع أي مجهود أو نشاط مفاجئ .