Impact of Physical Therapy Intervention upon Ejection Fraction in Patients with Mild Coronary Artery Disease

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ABSTRACT

This work was conducted to measure the effect of physical therapy intervention in a form of cardiac rehabilitation program upon the ejection fraction in patients with coronary artery disease. Forty patients with coronary artery disease (28 males and 12 females) participated in the study. Their age ranged from 45 to 55 years. The sample population was divided into two equal groups. Group (A) received cardiac rehabilitation program (CRP) for 16 weeks (3 sessions / week) while group (B) did not receive that program. The results showed statistically significant improvement in resting heart rate, systolic blood pressure, and diastolic blood pressure with group (A) more than group (B). There was no significant change in ejection fraction in both groups, during and after the cardiac rehabilitation program. However, the results showed that statistically significant improvement was happened after sixteen weeks in-group (A) and no significant changes was recorded in group (B).

Key words: *Ejection fraction, Secondary prevention, Coronary heart disease.*

INTRODUCTION

Coronary artery disease (CAD) continues to be a leading cause of morbidity and mortality in most developed countries and many developing countries[3]. While incidence of CAD is decreasing in Europe and United States, it is steeply increasing in Africa and to some extent in Asia[1,2,5]. Patients with established CAD are at serious risk of subsequent vascular events non-fatal myocardial infarction, non-fatal strokes, and cardiac death[8,9]. These risks can be reduced by effective clinical and preventive care. Studies showed that the quality of such care in hospitals and general practice is inadequate[4,6,9]. Assessment of risk is often incomplete, and many patients whose risk could be reduced are not receiving the optimal management[5]. Secondary prevention refers to preventive measures used for patients with established diagnosis of CAD; these interventions are designed to prevent subsequent coronary events and cardiac death[7].

MATERIALS AND PROCEDURES

Subjects

Forty patients suffering from anginal chest discomfort were included in this study, with age ranged from 45 to 55 years and a mean age of 50. They were divided into two groups equal in number: a study group which

included [6 female and 14 males] and a control group including [6 female and 14 males]. Their selected criteria were as follow: All patients had a history of anginal chest discomfort, proved by angiographic documentation of equal or lesser than 50% stenosis of a major epicardial coronary artery. All were physically inactive or had a sedentary life; their ejection fraction was greater than 55% and of average normal body mass index. No change in medication was conducted before or during the entire duration of the study. The subjects were referred from the Out-patient Clinic of Cardiology at National Heart Institute in Cairo. Patients with uncontrolled hypertension or patients with diabetes mellitus (DM), smokers, had one or more specific heart diseases were excluded.

Materials

The following instrumentations were used for either evaluation or treatment:

1) Instrumentation for evaluation:
- Weight and height scale
- Echocardiogram
- Sphygmomanometer

2) Instrumentations for treatment:
- Free weights and elastic bands
- Electronic treadmill

Procedures

Subjects were divided into two groups equal in number, study group (group A) received cardiac rehabilitation program (CRP) and control group (group B) did not received CRP.

[I] All subjects before starting the program, underwent the following:

i) Cardiovascular examination:

Left ventricular systolic function: All patients under-went a complete resting echocardiographic model study according to the study protocol[10]. Resting Heart Rate (RHR) was measured while the patients supine lying comfortably for five to ten minutes[6]. Regarding group (A), RHR was recorded four times during every session. The mean of these readings considered as the base line of RHR. Peak Heart Rate (PHR) was calculated to be 0.65 x Age (years)[9]. Resting blood pressure measured while the patient was sitting comfortably for five to ten minutes and the cuff arm supported at the heart level[2]. At initial screening, the patients of both groups asked to explain their usual pattern of physical activity to determine a relative measure of how much physical activity has been carried out[13]. Maximal upper and lower body isotonic strength was measured by determining the maximum weight that could be used to complete one repetition (i.e.1- repetition maximum, 1- RM)[11].

ii) Body mass index was calculated by measuring weight (kg) x height (m2). Obese subjects with is BMI > 28 kg / m2 were excluded (10).

[II] The cardiac rehabilitation program:

The methods designed for cardiac rehabilitation program (CRP)[3,6,9,10,11] composed of the following phases: I-Warming up exercise phase: Exercising at a low intensity for five minutes in form of stretching and breathing exercise. II-Conditioning Stimulus Phase: consists of endurance training on an electronic treadmill at limit of 65% to 70% of exercise testing heart rate (HR) according to modified Bruce protocol for every patient. Strengthening exercise: The patient exercised using free weights and elastic bands. Strengthening training consisted of one set of eight to ten repetitions at 40% of the patient's one-repetition maximum (1-RM). A rest period (usually 30 seconds to one minute) was taken between each set of exercise. HR and BP were measured at this period to insure that PHR was not increased or decreased from

the limit of intensity in the study. Exercise intensity increased from 40% to 60% of PHR at the end of the protocol when patients achieved high level of strength. The resistance exercises were composed of: Elbow flexion (biceps curl) Shoulder press Shoulder flexion Upper back Hip abduction Knee extension, Calf raise. III-Cooling down Phase: Including the same types of exercises that was underwent in the warming up phase, IV-Relaxing Phase: At the end of cooling phase, the patient was instructed to lie supine in a comfortable bed with pillows for support in a quite room. Then he/she was trained how to relax all the body through contract-relax techniques, which was applied to all the large muscles of the head, neck, trunk, and legs.

RESULTS

The results of this study examined the effect of CRP on the following parameters. Resting heart rate (RHR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and ejection fraction (EF) in group (A) and group (B) at pretreatment, after eight weeks and after sixteen weeks.

Resting heart rate (RHR):

From table (1) there was high statistically significant difference between both groups after eight weeks, P<0.001. Also there was high statistically significant difference between group (A) and group (B), P<0.001 after sixteen weeks. Group (A) has a lower RHR reading than the control group (B) after eight weeks" and sixteen weeks, fig. (1). Otherwise, the pretreatment values of both groups showed non-statistically significant difference.

Table (1): Shows comparison between values of the resting heart rate between both groups.

RHR (bpm)	Group (A) No. = 20		Group (B) No. = 20		P value
	Range	Mean ± SD	Range	Mean ± SD	
Pre	67-92	80.2±6.44	75-95	81.95±5.55	>0.05
After 8 wk	65-78	72.15±3.89	75-96	81.65±5.82	<0.001
After 16 wk	65-78	65.05±2.89	74-95	82±5.73	<0.001

PHR = Resting heart rate bpm = beat per minute
P > 0.05 = no significant P <0.001= High significant.
SD = standard deviation No = Number Wk = Week

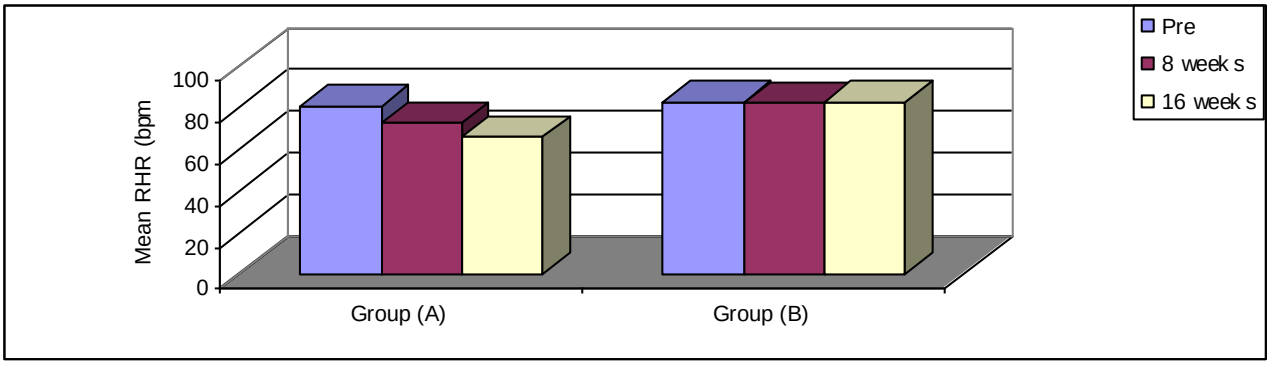

Fig. (1): Comparison between mean values of the resting heart rate between both groups at pre, after 8 weeks and 16 weeks.

Systolic blood pressure (SBp):

Regarding systolic blood pressure, the pretreatment range of both groups was 120-160 mmHg. Table (2) shows no statistical significant difference between group (A) and group (B) at pre treatment, p >0.05. While after eight weeks there was high statistical significant between both groups, P<0.001.Finally, after 16 weeks there was high statistical significant difference between group (A) and group (B), P<0.001. Group (A) showed significant decrease in SBp than group (B) after eight and sixteen weeks (fig 2). At the end of the treatment program, group (A) showed a significant statistical reduction in SBp than group (B) with a mean of 116.75±5.68 mmHg versus 135±10.13 mmHg.

Table (2): Shows comparison between values of systolic blood pressure between both groups at pretreatment, after 8 weeks, and after 16 weeks.

SBp (mmHg)	Group (A) No. = 20		Group (B) No. = 20		P value
	Range	Mean ± SD	Range	Mean ± SD	
Pre treatment	120.160	141.5±10.01	120-160	140.95±10.42	>0.05
After 8 wk	115-140	127.5±7.35	120-155	138.25±10.42	<0.001
After 16 wk	110-125	116.75±5.68	115-150	135±10.13	<0.001

SBp = Systolic blood mmHg = milimercury
P > 0.05 = no significant P <0.001= High significant.
SD = standard deviation No = Number Wk = Week

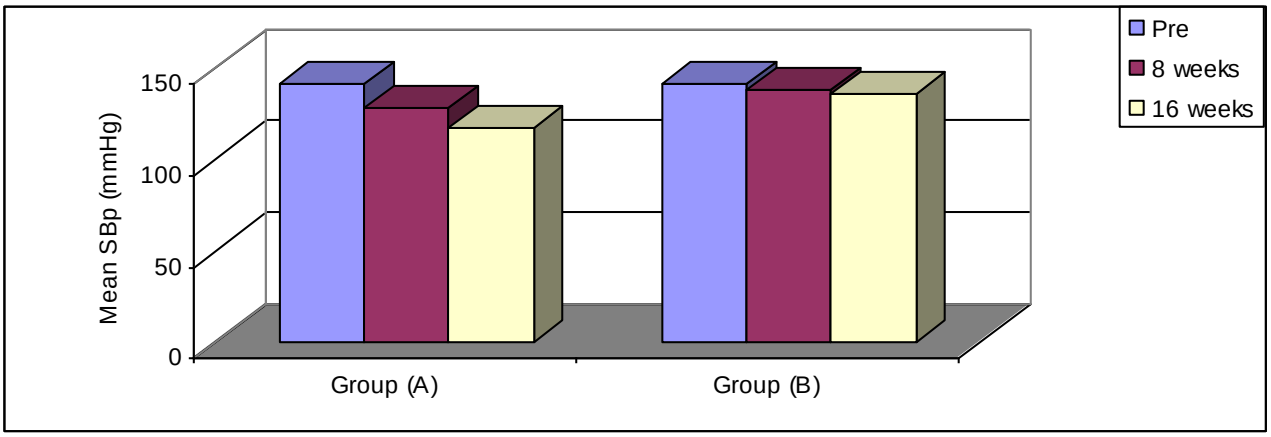

Fig. (2): Comparison between mean values of the systolic blood pressure between both groups at pre, after 8 weeks and 16 weeks.

Diastolic blood pressure (DBp):

As shown in table (3) there was no statistical significant difference between group (A) and group (B) at pretreatment measure. P>0.05. After eight weeks the values were showed high statistical significant difference between group (A) and group (B), P<0.001. The mean was 81.25±4.55 and 88.25±4.94 mmHg respectively. Finally after 16 weeks the data showed a high statistical significant difference between group A and group (B), P<0.001, fig. (3). The mean DBP in group (A) was reduced to a mean of 73.25±4.38 mm Hg after 16 weeks which is much more than that of group (B) with a mean of 88±4.7 mmHg.

Table (3): Shows comparison between values of diastolic blood pressure between both groups.

DBp (mmHg)	Group (A) No. = 20		Group (B) No. = 20		P value
	Range	Mean ± SD	Range	Mean ± SD	
Pre treatment	80.100	88.65±5.82	80-95	88.25±4.94	>0.05
After 8 wk	75-90	81.25±4.55	80-95	88.25±4.94	<0.001
After 16 wk	70-80	73.25±4.38	80-95	88±4.7	<0.001

DBp = diastolic blood pressure mmHg = milimercury
P > 0.05 = no significant P <0.001= High significant.
SD = standard deviation No = Number Wk = Week

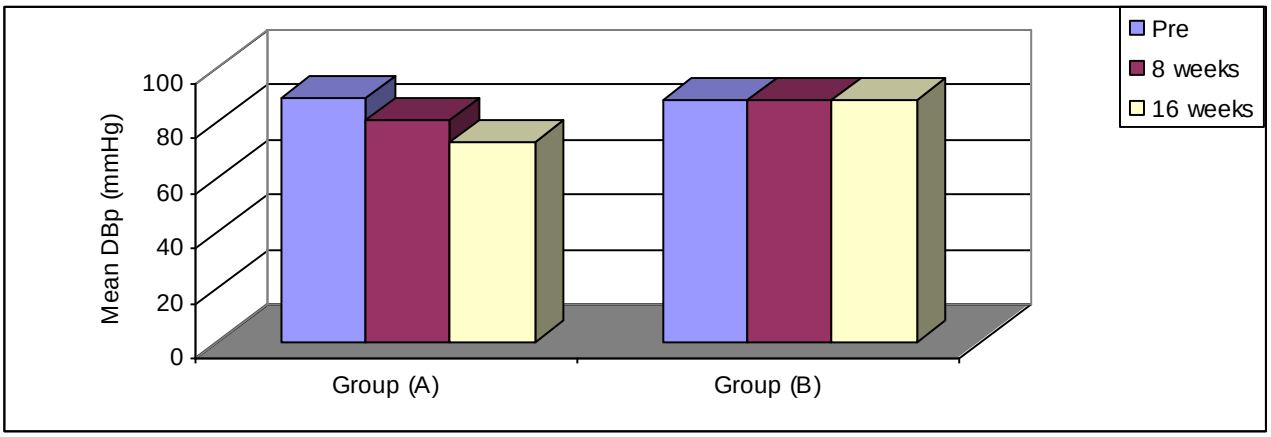

Fig. (3): Comparison between mean values of diastolic blood pressure between both groups at pre, after 8 weeks and 16 weeks.

Ejection Fraction (EF):

Among all the recording variables the most important finding was that of (EF).

The (EF) was 57.99±4.85 after 8 weeks and 57.99±4.64 after 16 weeks in group (B). This is nearly equal to the pre-treatment value which was 57.91±4.79, P > 0.05.

On the other hand, group (A) after 8 weeks showed no significant increase with a mean of 60.8±5.83 and more significant after 16 weeks with a mean of 62.53±6.39.

From table (4) one can notice no statistical significant difference between both groups in ejection fraction (EF) at pretreatment measure. Although group (A) showed higher (EF) than group (B) after eight weeks, there was no statistical significant difference between both groups, P>0.05. At the end of the study the data showed that there was statistical significant difference between both groups, P<0.01 fig. (4).

Table (4): Shows comparison between values of ejection fraction between both groups.

EF (%)	Group (A) No. = 20		Group (B) No. = 20		P value
	Range	Mean ± SD	Range	Mean ± SD	
Pre treatment	45.68.7	59.22±6.14	45-65.8	57.91±4.79	>0.05
After 8 wk	51.4-70	60.8±5.83	45-65.8	57.99±4.85	>0.05
After 16 wk	51.5-72	62.53±6.39	45.3-65.6	57.99±4.64	<0.01

EF = Ejection fraction P > 0.05 = no significant P <0.01= Significant.
SD = standard deviation No = Number Wk = Week

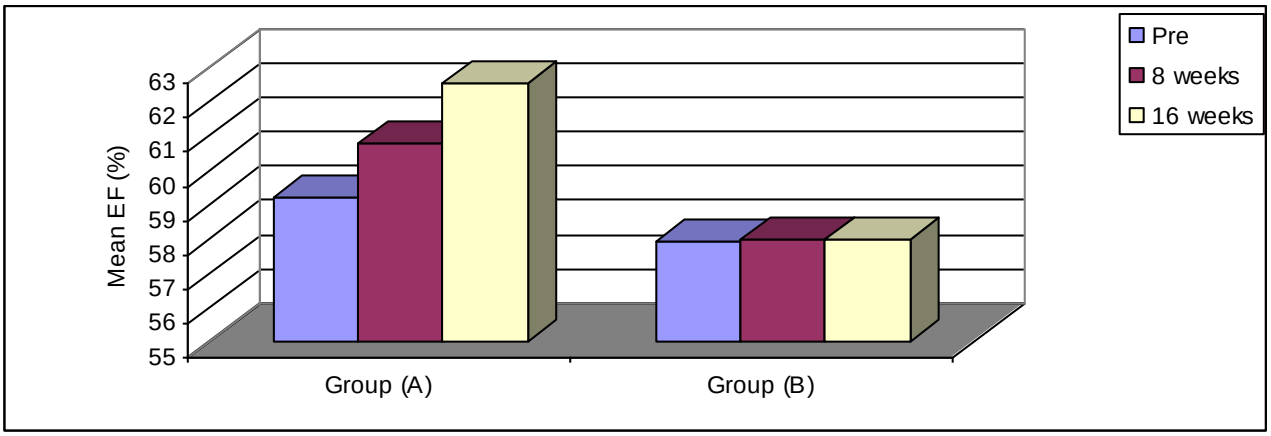

Fig. (4): Comparison between mean values of ejection fraction between both groups at pre, after 8 weeks and 16 weeks.

DISCUSSION

The effect of CRP on CAD patients examined through this study on main four variables. Resting heart rate (RHR), systolic blood pressure (SBp), diastolic blood pressure (DBp), and ejection fraction (EF). The variables measured at pre-treatment, after eight weeks and finally after sixteen weeks of treatment for group (A), the exercised group, and group (B) the control one. The results of this study can be discussed according to all variables as the following:

Resting Heart Rate (RHR):

The present study indicated that structured exercise training based on CRP is able to decrease RHR in patients with CAD. The results showed that the improvement of RHR at the end of CRP was 18% in group (A). The current results was supported by Assmann[3], who conducted an exercise training program that has been shown to decrease RHR and to prevent ventricular fibrillation, concomitantly improving cardiac electrical stability, in conscious dogs with and without myocardial infarction. Thus, exercise training based on CRP might be an effective non pharmacological tool to increase the vagal contribution to autonomic control of the heart in patients with CAD.

Recently, Tulppo et al.,[13] assessed the effect of moderate and high volume aerobic training on RHR. They found that after eight weeks the mean values of RHR was decreased for the moderate and high volume training groups.In addition they found that there were no significant differences in the changes of HR incidences between both groups. Finally they concluded that aerobic training for sedentary subjects results in altered autonomic regulation of HR toward vagal dominance and a moderate training volume was sufficient intervention to induce these beneficial effects.

The same result was achieved in another study by Bowles et al.,[7], which conducted to determine the physiological effects of exercise training on RHR. The study found that in trained mice RHR was significantly slower than sedentary mice and suggesting that exercise training improved RHR due to change in vagal response resulted from presynaptic facilitation of neurotransmission[7].

Blood Pressure (BP):

One of the interesting findings in this study was a significant reduction of both systolic blood pressure (SBp) and diastolic blood pressure (DBP) after eight and sixteen weeks of CRP. The improvement of SBp was 17.5% and DBp was 17.4% at the end of sixteen weeks.

In agreement with other previous studies, that proved that a moderate–intensity activity produced a reduction in DBP and greater reduction in SBP. The study was a prospective examination of the total physical-activity score, walking, vigorous exercise, and hours spent sitting as a predictors of the incidence of coronary event and total cardiovascular events[4,5,11].

These findings agree also with a previous study which was investigating the effect of exercise in patients with hypertension. That study found that, the patients with moderate to sever hypertension showed a significant reduction in Bp. In addition to reduced Bp, endurance exercise training improves exercise capacity and quality of life. These improvements may be reflected to metabolic adaptation and to reduction of other risk factors[10].

Many studies continued to indicate that exercise training decrease Bp in approximately 75 % of patients with hypertension with SBp and DBp reduction averaging approximately eleven to eight mmHg respectively. Also the findings showed that women may reduce Bp more with exercise training than men, and middle aged people with hypertension may obtain greater benefits than young or older people. Also they found that low to moderate intensities training appeared to have the same effect[8,11].

Ejection Fraction (EF):

The results of the study indicated that there is no significant improvement of EF in group A after eight weeks while the improvement was highly significant after sixteen weeks (5.5%). While group (B) showed no significant statistical differences either after 8 or 16 weeks. This concept indicated that, the improvement of EF need prolonged time of endurance training and strengthening exercise to produce this palliative effects[3,9,11].

In another study, for testing the hypothesis of training–induced improvement of EF. Ten elderly sedentary men exercised for ten months at intensity of 60 - 70 % of VO2 max and increase progressively to 70 - 80 %. The results showed a 28% increase in their exercise capacity. In addition, they found improvement of EF and fraction shortening (Fs). They explained these improvements by increasing in pre-load and /or lowering in aortic impedance after load[9].

This result was agreed with Ades et al.,[1] who studied the improvement of EF by exercise training in patient with CAD and concluded that EF improved after three months by 3% in response to training program. They were explained the possible mechanism to EF improvements after exercise training by favorable adaptation in the coronary circulation.

In a prospective randomized trail which conducted among 1994 to1999 to evaluate the effect of exercise training on EF and hemodynamic response to exercise in patients with stable chronic heart failure (CHF), presented that after six months, patients in the exercise training group had a statistically significant improvement compared with control one. The improvement was in exercise capacity, RHR, increase stoke volume (SV), as well as an increase in resting EF from base line to six months follow up that were determined. They referred these adaptations to

exercise training group to central as well as peripheral changes in the training group[5]. In agreement with Bellardinlli et al.,[4], who concluded that there was a significant correlation between the magnitude of training bradycardia and the increment in EF. Also they concluded that the relative bradycardia at comparable exercise workloads produced by exercise condition was associated with improvement in EF as assessed by the radionuclide ventriculography. These observations were compatible with the hypothesis that training bradycardia in conditioned CAD patients was associated with lower myocardial oxygen demand and lesser degrees of ischemia at comparable workloads.

The electrophysiological study was proved that endurance exercise training for sixteen weeks on nine swimmers showed increase voltage–gated calcium channels which regulate vascular tone on both normal and disease status. This information could provide a vital mechanistic link between exercise training and associated increase in contractile myocardium[7].

Conclusion

The present study confirms that careful structured exercise training program in a cardiac rehabilitation program is feasible and effective in improving cardiac function (central), exercise capacity, and quality of life as a secondary prevention of patients with coronary artery disease without previous myocardial infarction. These patients may benefit from physical training without any additional deterioration or other adverse events. More importantly, the present data indicates that in coronary artery patients, cardiac rehabilitation program improves ejection fraction, which is the powerful predictor for survival over a time. Thus cardiac rehabilitation program should be recommended as a useful adjunct to the existing medical treatment, not only to attain symptomatic and functional improvement but also to improve ejection fraction in patients with coronary artery disease. From the results of the present study, which supported by previous studies, the conclusion that the exercise training based on CRP is important for CAD patients with and without previous MI.

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الملخص العربي

تأثير تدخل العلاج الطبيعي على ضخ الدم الشرياني الانقباضي لدى مرضى القصور المتوسط بالشريان التاجي

يعتبر مرض قصور الشريان التاجي المسبب الرئيسي للوفاة للدول المتقدمة وكذلك يزداد حدوثه في الدول النامية . وقد أجرى هذا البحث لدراسة تأثير برنامج تأهيلي للقلب على هؤلاء المرضى لمعرفة مدى الاستفادة من هذا البرنامج وقد قسم المرضى إلى مجموعتين . المجموعة التجريبية والتي تتكون من عشرين مريضاً لإجراء البرنامج التأهيلي والمجموعة الضابطة والتي تتكون أيضاً من عشرين مريضاً والتي لم تتلقى هذا البرنامج التأهيلي. وقد تم اختيار هؤلاء المرضى بعناية للتأكد من دقة مواصفات دخولهم أو استثنائهم من هذه التجربة. وقد أجرى البرنامج التأهيلي لمدة ستة عشرة أسبوعاً على المجموعة التجريبية بمعدل ثلاثة مرات في الأسبوع طوال فترة التجربة. وأستخلص من نتائج هذا البحث حدوث تحسن ملحوظ بالنسبة لمرضى المجموعة التجريبية لمعدل نبضات القلب و لضغط الدم الشرياني الانقباضي والانبساطي والضخ الجزيئى بينما لم يتم أي تحسن في المجموعة الضابطة. وأظهرت النتائج أهمية استخدام البرنامج التأهيلي لمرضى الشريان التاجي كوقاية ثانوية من حدوث مضاعفات وخطورة كبرى المصاحبة لهذا المرض .

الكلمات الدالة : الوقاية الثانوية ، التاجي ، الضخ الجزيئى .