Effect of Concurrent Training on Left Ventricular Contractile Function in Patients with Coronary Artery Disease

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Abstract:

Field: Physical Activity has an accepted role in cardiac rehabilitation, which is due to more for its positive effects on blood stream of cardiac muscle in coronary artery patients. The mechanism of this improvement is questionable and improvement of medium vascular system and contractile function of cardiac's muscle have suggested as possible adjustments. The aim of this study is the study of combinational exercise on left ventricular contractile function in the patients with coronary artery disease.

Methodology: Twenty-four (24) coronary artery patients were divided into two experimental groups (average age: 60+/- 6 old, average weight: 74+/- kg, and average index of body mass: 26+/-4) as randomly (n=12) and control (n=12) groups. Experimental group participated in combinational exercise for 3 months, three times in a week for 60-80 minutes and the maximum heart beat was seen in 70% to 85% and 40% to 60% participated in a maximum repetition. The studied variables were evaluated primarily and at the end of plan with Impedance Cardiography method.

Findings: The exercises caused meaningful decreasing of heart beat and rest blood pressure of patients. Acceleration index of blood output (ACI) increased from 0.49+/- 0.14 to 0.78+/-0.24 in square seconds ($P<0.05$). Velocity Index of blood output (VI) increased from 36+/-9 to 47+/-8 milli seconds ($P<0.05$). Left Cardiac Work Index (LCWI) increased from 3+/-1 to 4+/-1 kgm/square meters ($P<0.05$). Pre Ejection Period of blood (PEP) decreased from 91+/- 12 to 68+/-19 milli seconds. The Systolic Time Ratio (STR) decreased from 28+/- 5 to 21+/-6 ($P<0.05$). Left Ventricular Ejection Time (LVET) had no meaningful change.

Conclusion: We concluded that the combinational exercise may cause the improvement of cardiac muscle contractile function in patients with coronary artery disease.

Key Words: Combinational Exercise, Left Ventricular Contractile Function, Patients with Coronary Artery Disease, Impedance Cardiography

Introduction

Coronary Artery Disease (CAD) has caused to death and disability more than any other disease in the developed world and imposes more economical expenses. CAD is the most common serious, chronic and threatening disease of life in U.S.A where more than more than 12,000,000 persons suffer CAD, more than 6,000,000 persons have angina pectoris and more than 7,000,000 persons suffered once myocardial infarction. A full-fatness and full-energy diet, smoking and form of life without motion have been with the appearance of CAD. By increasing of city dwellers in the developing world, prevalence of risky factors of CAD is increasing in these points quickly. Severe increasing of CAD observes in the whole world and it will be converted to the most common cause of death in the world in the year 2020 in the whole universe possibly [1]. On the basis of report by WHO (World Health Organization), the chronic diseases had been the cause of 70% of the death in Iran that 42% of them have been patients with coronary artery diseases. Also, in accordance to the report of the mentioned organization, CAD has devoted to itself the first rank with 21% among 10 causes of death and it considers as the most important cause of death [2&3].

During two recent decades, the effects of physical activity have accepted on the patients with coronary artery disease. Physical activity causes to increasing the function, rising Angina threshold and improvement of Myocardial perfusion [4]. These useful effects are resulting from adjustment in skeleton muscles and/or autonomic neural system and recently the improvement of myocardial perfusion or contractile function in these patients [5]. There is no doubt about the effects of physical activity on making environmental adjustments and increasing of potential aerobic and this matter has reported in many researches, but there are many contradictory reports about making central adjustments which the kind, period and acceleration of exercise program may be the causes of these differences [6,7,8].

With regarding to this point that the previous researches have focused on study of the effect of aerobic and resistance exercise separately on the left ventricular contractile function in patients with coronary artery disease, the aim of the current research is the study of the effect in a period of combinational exercise of aerobic and resistance exercises on the left ventricular contractile function in patients with coronary artery disease.

Methodology:

The current study is in the kind of semi-experimental. Twenty-Four (24) male patients were selected with average age of 60+/-6 whose disease diagnosed by Angiography method without any Valvular heart disease and with normal sinus rhythm. Five (5) patients among them had previous record of addiction to smoking cigarette and ten (10) of them had previous record of participation in physical activity. None of them shows the cardiac infarction and just one of the patients had the previous record of coronary artery bypass operation in accordance to ECG diagnostic study. Taking medicines in the patients were as follow: 12 patients: Propranol, 18 patients: Nitrocontine, 7 patients: Furosemide, 5 patients:Digoxine and 10 patients: Verapamile. This patients divided into two groups of experimental (n=12) and control (n=12) randomly. Experimental group participated in 12 weeks of physical activity, three times a week and each session for 60-80 minutes and control group performed daily works merely. Peak heart beat determined for each subject by usage from sport test on revolving tape and on the basis of modified Bruse Protocol [9]. The subjects used the peak power test in the movements with weight on the basis of Brzycki Protocol [10].

Table 1- The Particulars of Patients, Their Heart Beat & Blood Pressure in Rest Situation

The Particulars of Patients	Experimental Group (Deviation Standard+/-Mean)	Control Group (Deviation Standard +/-Mean)
Age (Old)	61+/-8	58+/-4
Height (cm)	166+/-7	170+/-4
Weight (kg)	75+/-9	72+/-14
Index of Mass Body	26+/-3	25+/-5
Heart Beat (beats/min)	before:73+/-6 After: 64+/-8	before:+/-8 after:73+/-7
Systolic Blood Pressure (mm Hg)	before:144+/-17 After: 121+/-13	before: 134+/-11 after: 139+/-11
Diastolic Blood Pressure (mm Hg)	before: 90+/-12 after:*79=/-12	before:82+/-15 after: 79+/-16

Then, the program of exercises for each one of the subjects prescribed individually and on the basis of collected information. Exercise program of subjects was as following: 60-70 minutes warming, walking on revolving belt in 60-75% with peak heart beat, resistance exercises (the movements of breast, armpit, fore-thigh, abdomen and the movements in steep surface) in 40-50 % with 1 repeat maximum and finally cooling in the first six weeks. In second six week, the subjects walked on revolving belt for 70-80 minutes with 70-80% of peak heart beat and resistance exercise in 50-60% of 1 repeat maximum [11].

The considered variables in the study were measured by Cardioscreen machine in the resting and in supine position before and after exercise program, while it is recommended to the subjects that to avoid from taking any medicine up to 24 hours before any test.

Cardioscreen is a non-aggressive method for homodynamic study of blood stream in aorta and situation of thoracic fluids with usage from Impedance Cardiography method (ICG). On the other hands, the alterations of volume and blood stream in aorta have determined in ICG method and to be used for computation of the other homodynamic parameters [12&13]. The Acceleration index (ACI) for output of blood stream shows the acceleration of blood in aorta in the primary 10-20 m/seconds for opening of aortic valve. ACI is with Velocity Index (VI) for output of blood stream. The maximum velocity of blood stream in aorta shows the myocardial cardiac rate. The numerical value of these two indices declines in the patients with coronary artery disease and one of the non-aggressive methods for identification of patients, who suffer the coronary artery disorder, is study of these indices. Left Cardiac Work (LCW), the rate of working which heart performs in each minute for blood pumping, will compute on the basis of cardiac output and mean of artery pressure. This index shows the working rate that the heart performs in a once specified work. The Left Cardiac Work Index (LCWI) is the ratio of mentioned parameter to the surface procedure of body. This index provides the possibility for comparison of individuals with different height and weight. Pre Ejection Perfusion (PEP) is the time between the starting of electrical stimulus of ventricular up to opening the aortic valve. This stage is called electrical systole. It will increase in cardiac patients due to decreasing of myocardial contractile for myocard ischemia and increasing of heart beat as well as decreasing of pre-load. The Left Ventricular Ejection Time (LVET) is the time of between opening up to closing aortic valve. At this stage, the blood exits from heart and enters in aorta. Systolic Time Ratio (STR) obtains from the ratio of Pre Ejection Perfusion to Left Ventricular Ejection Time. The systolic time ratio has a reversed relation with Ejection Fraction (EF), with this meaning that STR>50 shows EF<50 and vise-versa.

Therefore, the indices of STR & PEP show the function of left ventricular and their decreasing indicates to the improvement of left ventricular function and myocardial inotropic situation [14].
The collected information was studied and analyzed by SPSS program. The affiliated T-Test was used for studying of information before and after exercises in each group with confidence interval 95%.

Results

The primary particulars of participator patients have presented in the study in the Table No.1 completely. These particulars were almost similar in two experimental and control groups. As it is seen, the heart beat, systolic blood pressure and diastolic blood pressure have meaningful changes after implementation of exercise program, while these changes are not meaningful in control group.
The measured indices from patients of experimental group have rendered before and after combinational sport exercises. As it is considered, the exercise resulted to making some meaningful changes in all variables except of Left Ventricular Ejection Time. These changes state effectiveness of physical activity on the Left Ventricular Function in the Patients with Coronary Artery Disease.

Table 2- Indices of Left Ventricular Contractile Function of Experimental Group before and after Combinational Exercise Program

Contractile Function Indices	Before Combinational Exercise Program (Deviation Standard +/- Mean)	After Combinational Exercise Program (Deviation Standard+/-Mean)	P
Acceleration Index for Blood Output (sec^2)	0.49+/-0.14	0.78+/-.24	*0.000
Velocity Index for Blood Output (msec)	36+/-9	47+/-8	*0.000
Left Cardiac Work (kg m)	5+/-1	7+/-1	*0.007
Left Ventricular Work Index (kg m/m^2)	3+/-1	4+/-1	*0.028
Pre Ejection Perfusion Stage (msec)	91+/-12	68+/-16	*0.002
Left Ventricular Ejection Time (msec)	296+/-37	291+/-43	*0.469
Systolic Time Ratio	28+/-5	21+/-6	*0.019

- P≤ after against before.

Table 3- Left Ventricular Contractile Function Indices of Control Group Patients before and after This Stage			
Contractile Function Indices	Before Stage (Deviation Standard ± Mean)	After Stage (Deviation Standard ± Mean)	P
Acceleration Index for Blood Output (sec 2)	0.47±0.14	0.49±0.12	0.475
Velocity Index for Blood Output (msec)	35±9	41±11	0.105
Left Cardiac Work (kg m)	5±1	5±1	0.764
Left Cardiac Work Index (kg m/m2)	3±1	3±1	0.210
Pre Ejection Perfusion (msec)	86±44	84±41	0.265
Left Ventricular Ejection Time (msec)	288±30	287±38	0.860
Systolic Time Ratio	31±17	31±16	0.720

- $P \leq 0.05$ after against before.

Table 3 shows the left ventricular function indices of the patients with coronary artery disease before and after 12 weeks. As it is seen, the changes of left ventricular function haven't extended after this period and it is not meaningful from the point of statistical view. Of course, this issue was predictable with regarding to this point that the drugs have a semi-life between 10 minutes to 8 hours [15].

Discussion

The results showed that the combinational exercise have meaningful effect on the heart beat of the subjects in experimental group. The findings of this research confirm the results obtaining from previous studies about relation between resting heart beat and physical activity [7,16,17,18,19,20,21,22,23,24,25]. Decreasing in heart beat is due to increasing of vagus nerve tune and decreasing of sympathetic activity in resting position [26]. Also, it can be due to increasing of cardiac output and improvement of oxygen transferring and increasing of stroke volume and/or due to cardiac drugs especially ß-blockers in the subjects, where there wasn't seen a meaningful change in their beats with regarding to taking these medicines by the subjects in control group[7,19]. This result confirms the Dixhoorn [24] and Redood [25] findings.

The results of this study showed that the combinational exercises have meaningful effect on systolic and diastolic blood pressure in coronary artery patients who are in rest. The findings of this research confirm the resulting obtaining from previous studies about the relation between rest blood pressure and physical activity [7, 17, 18, 19, 21, 23, 25]. Also, this study approves the finding of Dixhoorn [24], Franklin [27] and Ehsani [18], who reported a meaningful decreasing in blood pressure of the patients who were in rest. Nevertheless, the results of Mayer et al. [28] indicated to non-changing in blood pressure which its cause was the usage from resistance exercises possibly that was seen such exercises had no considerable effect on blood pressure. Decreasing of blood pressure in the rest position can be resulting from decreasing of tighter sympathetic nerves and regular vascular resistance which decreases due to aerobic activities [7,29]. But, the equipment which cause such position completely, haven't known.

The results of research confirm the meaningful effect of combinational exercises on acceleration index for Cardiac Index(ACI) and velocity index for Speed in Vascular System(VI). The results of researches show that the numbers of these two indices decrease due to suffering coronary vascular disease. Unfortunately, there were no

researches on the basis of assessment of physical activity effect on these two indices in coronary vascular patients, due to the same reason, the researcher just mentions effective possible mechanisms. These changes occur because of myocardial contractile increasing and vascular regular resistance decreasing, blood pressure and after load. In fact, it seems that the best results in improvement of ACI and VI obtains when both aerobic and resistance exercise to be considered with relatively high acceleration until causing to obtain the best result in parallel to vascular regular resistance decreasing and myocardial contractile increasing [6,30].

The findings of research showed that the combinational exercise on Left Cardiac Work (LCW) and Left Cardiac Work Index (LCWI) have meaningful effect. These findings confirm the previous reports on the basis of improvement of cardiac function [29,31]. The improvement of cardiac work occurs due to Myocardial Ischemia decreasing, vascular regular resistance and heart beat as well as improvement of left ventricular contractile function which is affiliated to exercise acceleration. This matter, which the mentioned improvement hasn't seen in some researches, is possibly resulting from low acceleration of exercise. Therefore, increasing of acceleration, period or duration, and repetition and generally regarding to excess load is a very important and determiner factor in cardiac adjustment with new working acceleration [6].

A meaningful decreasing was seen at this study in Pre Ejection Period (PEP) stage and Systolic Time Ratio (STR) in responding to the exercise which is a witness on development of left ventricular function in coronary vascular patients. But the changes in Left Ventricular Ejection Time were not meaningful. Increasing of Adrenergic activity occurs due to some factors including anxiety and severe exercises. It seems that combinational exercises cause increasing of adrenergic activity and decreasing of PEP & STR. The other effective factors on PEP include of systemic blood pressure, changes pre load and myocardial contractile changes [5].In the patients of exercise group, as it is seen, the rate of resting blood pressure had meaningful decreasing. While, a meaningful improvement was seen in myocardial contractile indices including velocity and acceleration indices for Left Ventricular, which shows myocardial contractile increasing. Therefore, we can conclude that myocardial contractile increasing is a reflection shorter than PEP and decreasing of STR. The results of this study confirms the findings of Martin on the basis of STR & PEP decreasing and no changing of LVET and finally left ventricular contractile increasing due to alternative severe exercises [5].

The results of this study showed that combinational exercises can central and myocardial adjustments in coronary vascular patients too in addition to making environmental adjustments and result to myocardial contractile increasing. This result is similar to some obtained results in the health individuals. We can benefit from combinational exercises for decreasing of Ischemia incidence and increasing of cardiovascular function in the patients with coronary vascular disease in accordance to the obtained results in this study.

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