Comparing Two Methods of Alternating and Continuing Aerobic Exercises on Some of the Cardiovascular Physiological Indices of Patients after Coronary Artery Bypass Graft Surgery

Elmira Hakimi
Department of Physical Education and Sport Sciences, Science and Research Branch, Islamic Azad University, Guilan, Iran

ABSTRACT: Cardiovascular diseases and especially the most important one of them which is the Coronary Artery Disease (CAD) is the main reason of deaths of the world today. This study aims to compare the effect of two kinds of alternating and continuing aerobic exercises on the selected cardiovascular physiological indices in patients after the coronary artery bypass graft surgery including heart rate, systolic and maximum diastolic blood pressure. This research is a semi-empirical research and designs pre-test, post-test with the control group. The exercising program consists of 24 sessions, 3 days a week for period of 1 hour per session. The participants are 10 female patients and 20 male patients in the second level of cardiac rehabilitation, and they were randomly placed into three groups of 15 individuals (alternating, continuing and control group). The one-way ANOVA was used for comparing the effect of exercises, and the Tukey's test was used for the significant difference. The significance level for all of the tests was considered as $P \leq 0.05$. The results showed that a significant difference exists between the alternating and continuing exercises on the maximum systolic blood pressure ($p = 0.005$) and maximum diastolic blood pressure ($p = 0.009$), mean arterial pressure ($p = 0.000$), maximum heart rate ($p = 0.004$), BMI ($p = 0.02$) and weight ($p = 0.012$).

Key words: Coronary Artery Disease (CAD), alternating and continuing exercises, blood pressure, arterial pressure.

INTRODUCTION

In year 2009, 785,000 American suffered from first heart attack, and nearly 470,000 American suffered from second heart attack, it is estimated that 195,000 silent heart attacks occur per year, which means that each 34 seconds an American will have a heart attack. Coronary artery disease is the number one disease in the list of male and female’s deaths, and it is responsible for 20% of the deaths. The results of the WHO research in 21 countries showed that 4% of the deaths caused by coronary artery disease have reduced. Actions such as surgery actions and emphasizing on the lifestyle modification resulted in the reduction of deaths (Brian, 2012). Cardiovascular diseases and especially the most important one of them which is the Coronary Artery Disease (CAD) is the main reason of deaths of the world today (Tiukinhoy, 2003). This disease causes severe pathogenicity, and inability and loss of individual’s performance and it is the main reason of high costs of health. Coronary artery diseases include chronic stable angina, Unstable Angina, Acute Myocardial Infarction, and Ischemic. Elder age, male gender, and family history are some of the unchangeable risk factors, and changeable risk factors include Hyperlipidemia, hypertension, smoking & Diabetes mellitus, and other risk factors include obesity, sedentary life, estrogen deficiency in women (Smelters, 2004). Metabolic syndrome is another risk factor which causes obesity, fat around the abdomen, hypertension, impaired glucose and lipid metabolism which increase the heart diseases (Gaida, 2008). The clinical syndromes of coronary artery disease are definitely the results of underlying atherosclerotic coronary artery, and by accumulation of lipids, fatty substances, and fibrous tissue are characterized in the vessel wall and result in narrowing of the arteries and reduce blood flow to the myocardium and create the sudden cardiac death or acute myocardial infarction caused by ischemia (Smelters, 2004). Myocardial ischemia is a condition of reduction in the perfusion, and during which the oxygen distribution to the myocardium for supplying the metabolic
needs is inadequate (Fletcher, 2001). Angina is a clinical syndrome which is characterized by pain attacks or pressure on the anterior chest and its reason is due to inadequate blood flow to the coronary, which results in atherosclerosis and it has different kinds (lee, 2012). Inadequate blood flow to myocardium results in atherosclerosis and full arterial obstruction and the myocardial cells destroy completely and results in myocardial infarction (Smelters, 2004). In order to reduce the need of myocardial to oxygen, the drugs and control of risk factors are used. Several methods are used for the process of myocardial vascular restoration such as: coronary artery bypass graft surgery (CABG), percutaneous coronary intervention or angioplasty (PTCA), and percutaneous coronary intervention (PCI), and other invasive methods. Fortunately, by the use of more modern medical procedures, the death rate caused by the coronary artery diseases of few past decades are gradually decreased and this in debt of the reduction of risk factors through the on-time screening and running prevention and cardiac rehabilitation programs. The patients' situation after the surgery was critical and due to the effects of surgery and absolute inactivity of the patients they had lower motor and functional abilities. Most of these patients complain about the chest pain and other side effects caused by drugs. Some of the most important adverse consequences of coronary artery bypass graft surgery include: forced inactivity, pain in the surgery area (chest), pain in the vein harvest site (chest, hand, and leg), reduction of quality of life and severe depression, reduction of libido, loss of appetite and effects of drug interventions such as excessive sweating (Bondaius et, al., 1998).

The aim of cardiac rehabilitation is to develop and improve the quality of life (Smelters, 2004). Since 1968 WHO defined the cardiac rehabilitation as a process that through which the individual returns to his/her desirable physical, psychological, sexual, employment and economic status (Parak, 2007). Regular exercising in patients with heart diseases creates adaptations in the musculoskeletal, cardiovascular, neuro – endocrine systems which improves the functional capacity, and reduces the death caused by this disease (Kevin, 2007). Due to this, many researchers came to this conclusion that running exercise programs in patients result in the increase of aerobic capacity, reduction of systolic blood pressure and reduction of heart rate (Marcus, 2003 & Myers, 2007). Hence, the way of occurring the heart failure disease and the effect of exercises are some of the most important goals of the medical and sports societies (Wilsof, 2007). In researches of Panoskiet, al. (2011) it has been shown that regular exercises improve the left ventricular function in the patients. According to the report of the Heart Association Statistics Committee and the StrokeStatistics Committee of America, the medical costs of coronary artery disease patients in year 2009 were estimated 165.4 billion dollars (Jones et, al., 2011). The continuing aerobic exercises are more used for cardiac rehabilitation patients and for alternating aerobic exercises there are less researches available. The current research aims to study two methods of alternating and continuing aerobic exercises and their effects on the patients after the coronary artery bypass graft surgery, and if the effects were positive it would be possible to avoid spending enormous costs and readmission. Patients who go under coronary artery bypass graft have pain in the surgery areas of chest and leg, loss of appetite, fatigue and sleep disorders (Lopez, 2007). Improving these problems need weeks, and months and rehabilitation program can play an important role in improving and reducing these effects. Several researches showed that by performing exercises after the coronary artery bypass graft, the performance of the substitute vessels and their lifespan increase (Jennifer, 2003). Most of the conducted studies showed that exercising with the purpose of cardiac rehabilitation reduce the death by 25% (Angourani, 1385). Also, the researches in recent years showed that the severity of exercises and type of the alternating protocol are the important factors in achieving more exercising benefits (Bryan, 2012).

For example, Wilsofet, al. (2007) showed that the high intensity interval exercises have more physiological benefits compared to the average intensity continuing exercises (Wilsof, 2007). Regarding the effect of intensity and type of the continuing and alternating exercise that are the most applicable methods of exercise for cardiovascular rehabilitation patients after the surgery, limited researches are conducted in this field, also it is not completely clear that whether the type of protocol and the intensity of the exercises could be of effective factors on the improvement of the performance indicators of the patients after the surgery or not and that which type of protocol has a significant effect on the improvement of the patients. Regarding the mentioned cases, and surveying the background of the conducted research about the cardiac rehabilitation, the aim of this study is to compare the effect of two selected methods of alternating and continuing aerobic exercises on the cardiovascular physiological indicators of the patients after the coronary artery bypass surgery in order to study the effect of amount of more alternations (alternating group) in one hand and to study the effect of more time period (continuing group) on the other hand on the cardiovascular physiological indicators, and the researcher is intended to take control of the control group along with the exercising group and to study the effect of influential confounding factors in the research results and reduce them to minimum, and somehow reduce the other researches limitations to minimum.
MATERIAL AND METHODS

This research is a semi-empirical research with proposing a pretest – posttest in the empirical and control groups.

The sample survey
The entire Coronary Artery Disease patients visiting the Ekbatan hospital located in Hamedan city (the only cardiac rehabilitation center of Hamedan) placed in the 2nd level of cardiac rehabilitation including patients being exposed to heart failure, heart surgery (valve surgery or an artery bypass surgery), percutaneous angioplasty, myocardial infarction, angina pectoris, all of them create the population of this research. The sample survey of this research is chosen from the patients who underwent Coronary artery bypass graft surgery and visited the Educational Rehabilitation Hospital of Ekbatan (rehabilitation center) in Hamedan. The invited examinees were the patients who underwent Coronary artery bypass graft surgery and passed 1 to 3 months after their surgeries and their age ranges are around 40 to 70. Then based on the intensity of heart failure, measure one to three of heart failure through the NYHA classification and having the MET of more than 5 in the exercise test, the fraction IV of more than 30% were chosen. The examinees were divided into three groups of control (15 individuals), alternating exercise (15 individuals) and continuing exercise (15 individuals) and after receiving the consent sheet they went under the exercise program. All of the patients did not have more than 5 consecutive session’s absenteeism during the exercise sessions. A specialized doctor checked all the patients’ history, history of cardiovascular disease, ECG, echocardiography, and exercise testing.

Measuring tools
Cardiac rehabilitation tools of MEASROSE including treadmill, ergometer and a complete set of ECG and heart rate control made in EU, model 5Lr.
Echocardiography device of FUKUDA made in Japan, model CF sonic uf 7200
Exercising testing device of CONTEC made in EU, model RAM 770
Manual ergometer made in Italy, model the techno gym wellness company

Test procedure
The effect of the rehabilitation program (psychological counseling - nutritional advice - exercise training program) was evaluated before and after 24 sessions of exercising. The chosen individuals for the research attended at the Ekbatan hospital in Hamedan one week earlier to start the implementing levels of physical and physiological tests. While filling the standard health history questionnaire and obtaining informed consent form based on the provided consent sheet of the Medical Ethics Committee of the Medical Sciences of Hamedan, all the information related to the examinees’ age, height, weight, body fat percentage, three areas of subcutaneous fat, waist-hip ratio, body mass index (BMI) and electro-cardiographs for surveying the R-R interval and conducting blood tests such as blood sugar, blood fat, CBC diff (after 12 hour fasting) were obtained before starting the exercises. GXT exercise test adjusted through Bruce methods (RPP) and also measuring the resting blood pressure for evaluating the effects of exercise on the systole and diastole blood pressure and MAP, maximum blood pressure (for evaluating the heart rate and determining the cardiac output power) were conducted and compared.

Type of exercising
In this research the alternating and continuing aerobic exercises were used separately on the patients. These exercises include 10-minute warm-up and 10-minute cool down. The exercising program was designed for the patients according to the proposed protocol of ACSM (David, 2007). In the first 5 sessions for surveying patients’ cardiac responses to the exercises, and the risk rate and evaluating the cardiac abnormalities, the intensity of exercises was adjusted on 70 to 85% of the peak heart rate on the devices. The maximum heart rate of the patient was designed according to the formula of age - 220= maximum heart rate. After 5 sessions, based on the no impairment of the heart function, and response to the exercises, the intensity of continuing aerobic exercises on the treadmill was adjusted from 70 to 85% and on the manual ergometer it was adjusted from 65 to 75%. The speed on the treadmill was determined as 3.5 to 5.5 and the intensity of exercise with manual ergometer was determined as 35 to 40 watt. In the second group with the alternating aerobic exercises the 5-minute warm-up,
intensity of treadmill walking 70 to 90% of peak heart rate, cycling on a cycle ergometer peak heart rate of 70 to 80% (8 to 40 watt), cycling with a manual ergometer peak heart rate of (40 to 60 watt) were determined. In the continuing exercises, the time of program on the treadmill and manual ergometer was 15 to 30 minutes, in the alternating exercises, the time of program on the treadmill was 10 to 20 minutes, and the time for manual ergometer was 8 to 12 minutes and cycling with the cycle ergometer was 8 to 12 minutes, and based on the individual conditions of the patients they take a rest between the exercises ranging from 5 to 10 minutes (Wilssof, 2007).

**Methods of statistical analysis**

Descriptive statistics (mean, standard deviation), are used for describing the primary features of the examinees, and Kolmogorov-Smirnov test (K-S) was used to study the normal distribution of the variables, also one way ANOVA was used for studying the effect of exercising on the exercising groups, and post hoc tests of Tukey’s HSD was used for studying and comparing the groups. All of the statistical calculations are analyzed by the use of statistical software of SPSS version 16.

**RESULTS**

Data analyses results showed that no significant difference exists between the maximum produced pressure in the continuing and alternating exercises. But the test results showed that a significant difference exits in the mean of resting blood pressure according to the intervention group in the continuing and alternating exercises.

Type of intervention

![Graph showing mean of resting blood pressure](image1)

Figure 1. Mean of resting blood pressure of patients according to the type of intervention.

Also data analyses results showed that a significant difference exists in the maximum heart rate in the continuing and alternating exercises.

Type of intervention

![Graph showing mean of maximum heart rate](image2)

Figure 2. Mean of maximum resting heart rate of patients according to type of intervention.
DISCUSSION AND CONCLUSION

Performance ability of patients suffering from cardiovascular disease depends on the performance capacity of their cardiovascular systems, which is originally dependent on the oxygen distribution to the heart muscle. The simplest way for surveying the amount of oxygen supply to the heart muscle is to check the produced amount of pressure which indirectly shows the amount of oxygen consumed by myocardium. On the other hand, other research results support this research results about the role of exercising on the increase of amount of produced pressure on the heart. The increase of produced pressure in patients is a sign of improvement in the heart function and their increased tolerance against the work pressure (Pacino et al., 2006). In research conducted by Gavin Drago and his colleague, on 210 patients of coronary artery disease, it has been shown that the endurance exercises result in the increase of maximum pressure produced in the patients, and the patients’ gender is effect less in this (Gavin, 1998). In this research, the produced pressure in the continuing group had a significant difference compared to the control and alternating group, which is probably due to the progressive dilation of peripheral vessels which result in the reduction of cardiac afterload. Research findings show that exercising results in increase of resistance of vasodilatation in patients who have heart failure (Pierson, 2002). Anyway, the vascular benefits of exercising are not limited to the involved skeletal muscles, and it is probable that the coronary vasodilatation takes place after the exercising period. In addition to rate pressure product (RPP), the maximum heart rate also decreases after a period of exercising. Probably this case is due to the cardiorespiratory fitness. Possibly the mechanisms for improving cardiac function in this research are caused by the fact that after the heart attack, the aerobic exercises prevent or reduce the heart deformation which can be due to the decrease of stenosis reduction caused by hormonal-nervous factors or reduction of hemodynamic pressure on heart. Also a significant difference exists in the indicator of maximum heart rate in three intervention groups, and a significant difference exists between the alternating and continuing exercises. In a meta-analysis research evaluating the effect of exercising on the blood pressure, it was shown that the systolic and diastolic blood pressure had a significant reduction after the exercises compared to before the exercises (Adams, 2011). This research results and the results of Myer et al. showed the increase of heart rate and Tjonna et al. showed the decrease of systolic and diastolic blood pressure during the alternating aerobic exercises (Afkhami-Ardakani, 2007). But alternating exercises did not result in the significant effect on the maximum heart rate, which was probably caused by the intensity and time period of the exercising program. Regular exercising helps to improve the performance capacity and reduce the blood pressure, and decrease in resting blood pressure can be due to the decrease of activity of the constrictor sympathetic nervous and the systemic vascular resistance which reduce by the aerobic exercises (Aghdasi, 1993 and Angourani, 2006). Generally, different mechanisms explain the effect of exercising on the reduction of resting blood pressure including: Sympathetic tone, weight loss, decreased insulin levels, weakening baroreceptor discharge of endogenous opioids and changes in systemic vascular resistance (Jalali et al., 2007 and Robert, 2008). Increase of maximum heart rate during the peak of exercise is an indicator of better heart function in the exercising time and heart perfusion and ultimately meeting the oxygen demand of heart muscle during the exercising (Thomas, 2004).

Research results showed that alternating and continuing aerobic exercises improved the indices of cardiac function in these patients. This increase probably depends on the intensity and type of the physical exercises. In some parameters a significant difference exists between the methods of continuing and alternating exercises, and it could be said that possibly the parameters of both types of exercising had different mechanisms on the vagal tone. Also, in the control group, significant difference exists in pretest, posttest of some of the variables, which is probably due to the fear of recurrence of disease, proper diet, proper use of drugs and regular visits to the cardiologist.

REFERENCES


