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Effect of Cardiac Rehabilitation on Strength and Balance in Patients after Coronary Artery Bypass Graft

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Abstract

***Background*:** The most common method for improving the quality of life especially in chronic heart disease is rehabilitation. For increasing the level of knowledge about effect of rehabilitation and its' impression on improving the quality of life in patients. This study evaluates effect of one month cardiac rehabilitation on lower limb strength and the static and dynamic balance of CABG patients.

***Materials and Methods*:** This study is based on clinical trial before and after rehabilitation. the exercise protocol lasted for one month, three times per week, each session lasting 1 hour, on 30 male patients in two groups in control (N=15) and experimental group (N=15) after CABG in the centre of rehabilitation in Javad-Alaeme Heart Hospital, Mashhad. The strength of lower limb by chair standing test, the static balance by standing on one leg and dynamic balance by time up and go (TUG) test, was evaluated before and after 1 month rehabilitation in training group and detraining in control group. Data were analyzed with SPSS-16 and used *t*-test analysis ($p \leq 0.05$).

***Results*:** The strength of lower limb ($p=0.001$), static balance ($p=0.023$) and dynamic balance ($p=0.037$) increased significantly after one month of cardiac rehabilitation.

***Conclusion*:** The result of this study indicates that cardiac rehabilitation after coronary artery bypass surgery causes significant increase in strength of lower limb and balance in patients, the more muscle strength is associated with an increase in ability of performing daily activities and so it causes improved quality of life.

Introduction

The prevalence of coronary artery disease in developing countries, including East Mediterranean is growing in recent years [1]. The most common method for improving the quality of life especially in chronic heart disease is rehabilitation [2, 3]. Evidence indicating the effectiveness of cardiac rehabilitation programs, so it provides 27% reduction in mortality after myocardial infarction (MI). Cardiac rehabilitation includes of comprehensive evaluation of medicine, exercise, modification of risk factors, education, counseling and changing behavioral in patient [4]. Recently, there is more attention to effect of exercise on cardiac rehabilitation. Pozehl et al. showed that exercise has beneficial effects on fatigue and shortness of breath in patients with heart failure [5]. Balance and strength are two factors of physical fitness. Balance is a complex motor skill that it describes dynamics body postural to prevent falling [6]. Punakallio defines balance in two parts in theoretical aspects; static (relying on the ability to maintain the center of gravity in the range) and dynamic (active motion of center of pressure during standing, walking or any other skill) [6]. Olmsted and Guskiewicz have been classified balance operationally in; static balance, semi-dynamic (maintaining a level of condition while the place moved) and dynamic [7, 8]. Ability of keeping balance widespread declines with increase of age; so exercise is important in increase of physical activity and reduction of complications of falling and improving of their ability to balance [9]. Physical activity also improves muscle strength, aerobic condition, flexibility, balance and quality of life [10].

Attarbashi et al. examined the effects of aerobic and resistance exercise training on functional capacity factors, blood lipid profile, blood pressure and muscle strength in cardiac rehabilitation. The result was reported further improvement in muscle strength after exercise therapy using the combined (aerobic+resistance) [11].

Dolansky, did investigation titled the effect of rehabilitation on the output of orderly's recovery after CABG. It included 65 patients (32 in rehabilitation, 32 in control group) with mean of 70 years old and upper. He evaluated the output of recovery in 2 different times; 6 weeks after CABG (before rehabilitation) and 6 month after rehabilitation. Exercise rehabilitation had been done 3 sessions per week for approximately 12 weeks (27 sessions of rehabilitation). The rehabilitation group showed maximum strength in lower body, extremity range of motion in ankle, improving balance (by Tinetti test), and the stability of the equilibrium position by Roberts and better walk and understanding of physical scale evaluated by HRQL questionnaire (Health Related Quality of Life). There weren't significant differences

between the groups in perceptions of HRQL and physical activity after 6 months. Study suggests the usefulness of cardiac rehabilitation in elderly [12].It is obvious that researches for effect of rehabilitation on physical ability in cardiac patients could give us new information and also new ways to control of death in cardiac patients. The review of researches showed that there isn't enough accurately quantified about this field in Iran and other countries. This study investigated the effects of cardiac rehabilitation on lower extremity strength and static and dynamic balance in cardiac patients after CABG.

Materials and Methods

This study has been done in centre of rehabilitation in Javad-Alaeme heart hospital, Mashhad. It did in 2011. Among patients undergoing CABG, the people who had the primary criteria were invited to participate in the study. Among these people that were volunteer and after checking qualification of entrance, 37 patients (20 men in experimental and 17 men in control group) were under research. At the end of the study, 30 patients completed the final test. The experimental group included 15 patients (mean age: 57.75±6.49 years; average height: 166.41±7.27 cm; average weight: 70.08±9.27 kg; BMI: 25.56±2.6 kg/m^2) and 15 controls (mean age: 57.3±4.21; average height: 166.8±4.54; average weight: 71.18±5.31; BMI: 25.6±1.94), respectively. The patients were in low risk and moderate risk and it classified based on diagnosed of proficient cardiac rehabilitation team's doctor.

Research criteria: age, don't have uncontrolled diabetes, low blood pressure less than 160 mmHg in systolic and 100 mmHg in diastolic pressure, absence of respiratory diseases and acute orthopedic problems, don't use of auxiliary devices for walking. Exclusion criteria of the study: the incidence of complex arrhythmias, elevation or falling ST-segment in ECG during training, respiratory disorders during the treatment, inability or unwillingness of patients for completion treatment.

The patient who had conditions and satisfaction to participate in the study, were randomly assigned to experimental and control groups. The patients participated in a public examination session before entering the rehabilitation program while the researcher and specialist were there. Furthermore in that session, the information about examined of patient and his medical history and other potential problems were recorded. To avoid interference of diet on results, the patients were under controlled by nutrition's specialist of rehabilitation. After the introduction and explanation to the patients about the study, tests were conducted for each factor. After rehabilitation in the experimental group, the tests were performed in both groups with the same initial conditions. Changes were evaluated. Control group were organized without any training activities. The principle of confidentiality of personal data and the results of this study were secured.

Tests: Chair standing test, to assess lower extremity strength, both the patient's hand was placed on the chest, and sit on a seat height of 40 cm and they moved sitting down stand up during 30 seconds. Test of static balance done by standing on one leg. To perform this test, a person standing on one foot with his arms leaned in waist or against of chest. Time was recorded in seconds. The test was finished when the person wasn't able to maintain his balance or moved his hands to the sides of his body and separates his hands from the body (this is an error in this test).

The dynamic balance measured by Time Up and Go test (TUG). The test started with the sign of researcher (go). Patient walk 3 meter and sat back. A person shouldn't running in this test. The time recorded was between the patient stand up from the chair and sit down again at the end [12]. The experimental group was undergoing cardiac rehabilitation for one month, three sessions per week. Sessions include 10-15 minutes warm up and stretching exercises, walking on the treadmill for 15 min, pedal on a stationary bicycle for 15 minutes and arm ergometer for 10 minutes. The warm up and cool down set on each machine at the end and beginning for 5 minutes. Stretching exercises and relaxation practice done at the end of each session for cool down and recovery.

Heart rate was monitoring during exercise and ECG data were recorded in the computer. Intensity of training was based on 55-75% of maximum heart rate (age-220) and Borg scale pressure was applied by the patient's report. Borg scale pressure was controlled in the range of 12-13. Intensity was increased per week, approximately 5% to target heart rate. The exercise was based on Pollock and Gomes protocol [13]. SPSS-16 software was used for data evaluation. The independent *t*-tests to assess between-group changes and paired sample *t*-test to assess within-group changes, was used with a significant level of 0.05.

Results

Comparing average of lower limb strength, between the experimental and control groups using independent *t*-test showed that one month rehabilitation improved this factor after coronary artery bypass surgery significantly. As can be seen in table 1, significant improvement was observed in static and dynamic balance in comparison between groups.

Table 1. Changes in evaluated factors

Factors	Group	Before rehabilitation Mean±SD	After rehabilitation Mean±SD	*p*-Value *	*p*-Value **
Lower Limb*** Strength	Experimental	1.72±7.91	3.91±13.58	0.01	0.01
	Control	1.47±7.8	1.37±7.9	0.67	
Static Balance (second)	Experimental	22.21±20.73	36.46 ±45.3	0.01	0.02
	Control	7.81 ±17.11	7.61 ±17.3	0.41	
Dynamic balance (second)	Experimental	2.78 ±10.71	1.26 ±6.9	0.01	0.03
	Control	4.38 ±10.26	4.3 ±10.36	0.27	

***** Paired sample *t*-test, ****** Independent sample *t*-test, ******* Based on number of repeats in 30 second

Also paired sample *t*-test comparing the mean within-group showed a significant increase in static and dynamic balance and lower limb strength in the experimental group than the control group ($p \leq 0.05$).

Discussion

The most important finding of this study was increasing of lower limb strength average, dynamic and static balance, significantly. It was happened after the heart rehabilitation in experimental group, in each part of between and within this group, in comparison of control group.

The results showed one month exercise by mentioned protocol, could increased strength, static and dynamic balance in patient, significantly. As the study Dolansky, after 6 weeks rehabilitation, maximum strength in the lower limb and better balance was showed, the assessment was by balance walking Tinetti test and by evaluating with questionnaires HRQL when these results were consistent [12]. In another study by Liu physical fitness factors was evaluated, after 12 weeks of Tai Chi training, in cardiac patients in 3rd phase of rehabilitation. This study showed increase strength and static and dynamic balance in patients after exercise [14]. Although different types of exercises used in this research, but the effect of exercise on these factors was the same.

Lentell et al. showed that the two major factors contributing to the instability of the performance, was proprioceptive function is anatomical stability [15]. Proprioceptive has critical role in balance. Proprioceptive sense has effect in postural control and movement by design and modification of endogenous motor commands before and during the execution of a motor command.

The movement control system should consider current status and changing joint to estimate complex balance of mechanical. In this field proprioceptive has the best condition to provide information and sending them to central nervous system. This is a complicated process that only proprioceptive afferent system can do it. The proprioceptive information played a major role in maintaining the stability of the whole body and localized areas (functional joint stability) [15]. According to the concepts explained, proprioceptive is vital for control of balance. Equilibrium level, relying on the ability to maintain body position on base on support.

During the static and dynamic balance, body situation is controlled by movement mass centre and beginning of appropriate answer for returning body to a stable condition; this is a complicated process that visual sense, somatic sense, auricular sense and musculoskeletal system, play an important role in it [16].

According to performance theory system, the ability to control the body's position in space is cause of complex interaction between the nervous system and skeletal-muscle system. According to system, the interaction of sensory data to detect body position in space and strength of musculoskeletal system to force, makes postural control, balance and finally movement as a result.

This theory shows effective element of musculoskeletal in balance regulation includes range of motion in joint, muscle characterization, correlation biomechanical of different part [17].

Reaching object, pushing the elevator button or opening the door, need to transfer weight forward, backward and the two sides that challenge the dynamic balance. During these activities, people should control their centre of mass around the base of support, in this condition the upper body moves and as a result it changes the centre of mass [18].

Standing on a leg that evaluated in this study, is a part of many daily human activities and is challengeable subject because in this situation body weight is on one leg and decrease the base of support [19].

In this study for examining static balance has been used standing on a leg test. As the previous research showed, standing on a leg improved after practice [18]. Our research has showed improving static balance after one month practice in CABG patients, significantly. Time up and go, is one of the measuring test for evaluated dynamic balance. We used this test for evaluating effect of rehabilitation in dynamic balance of CABG patients.

Era and Heikkinen believed in connection of aerobic and anaerobic fitness and strength of grip with control of postural system [20]. Generally the state of physical fitness has affect on dynamic balance indirectly [18], so we can make a relation between increase of balance in experimental group and improving level of physical fitness.

The finding of our study doesn't match with Chu et al. finding. In their study, 8 week practice in water hasn't significantly effect on balance in heart attack patients, while it has been showed significant improving on cardiovascular fitness, speed of walking and lowers limb strength. In this study, they didn't mention to balance system and they were believed that floating property of water and using the floating tools weren't challenged the balance system [21]. Although there are various results in different studies with titled effect of water training on balance, but the reason of different result with our study might be cause of difference in environment and the kinds of training. Dialectically doing body exercise, could improve the mechanism of balance with providing chance of training and made a challenging [19].

On the other hand, Judge et al. showed that resistance and stamina training wasn't effective on balance and amount of time for time up and go test that evaluated dynamic balance. The result of this study doesn't match with ours. Maybe it's related to the kind of used training or the first level of body fitness in person who participated in these studies [22].

Our finding confirmed improving standing on a leg with practice, that our result was consistent with Nagy et al., Rogers et al. and McCleanaghan et al. findings [23-25]. The more muscle strength is associated with an increase in ability of performing daily activities [26] and so it causes improved quality of life [27]. Whereas in this study weren't used any feedback or verbal encouragement for both of experimental and control group during the

tests, so researcher found out the mentioned protocol in this study that could improve static and dynamic balance in CABG patients was caused of reinforcement of muscles and lower limb flexibility and improving of operational proprioceptive and central nervous system, also it has been showed increase of lower limb strength in this study.

According to our results, it showed that using of mentioned protocol training in rehabilitation after CABG, has been significantly effected in improving static and dynamic balance of experimental group, and we could conclude doing regular practice improved strength of muscles especially lower limb muscles and maybe has been increased efficiency of nervous system and proprioceptives by training and so it cause improved balance in patient after CABG. As a result, these training could use by CABG patients in order to increasing ability for routine activities and improvement of quality of life in patient. Whereas there is low researches and no possibility of comparing, so it seems necessary wide researches about effecting of number of session, duration and intensity of different training on these factors and physical fitness in patient.

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Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest

The authors declare no conflict of interest.

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