Effect of exercise training program in post-CRET post-CABG patients with normal and subnormal ejection fraction (EF > 50% or < 50%) after coronary artery bypass grafting surgery

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Abstract: The aim of the present study is to compare the effect of exercise training program in post-Cardiac Rehabilitation Exercise Training (CRET), post-CABG patients with normal & subnormal ejection fraction (EF >50% or <50%) who have undergoing coronary artery bypass grafting (CABG) surgery. The study was conducted on 100 cardiac patients of both sexes (age: 57-65 years) who after CABG surgery, were referred to the department of Physiotherapy and Rehabilitation between 2008 and 2010 at Liaquat National Hospital & Medical College, Karachi. The patients undertook exercise training program (using treadmill, Recumbent Bike), keeping in view the Borg's scale of perceived exertion, for 6 weeks. Heart Rate (HR) and Blood Pressure (BP) were measured & compared in post CABG Patients with EF (>50% or <50%) at the start and end of the exercise training program. Statistical formulae were applied to analyze the improvement in cardiac functional indicators. Exercise significantly restores the values of HR and BP (systolic) in post CABGT Patients with EF (>50% or <50%) from the baseline to the last session of the training program. There appeared significant improvement in cardiac function four to six weeks of treadmill exercise training program. After CABG all patients showed similar improvement in cardiac function with exercise training program. The exercise training program is beneficial for improving exercise capacity linked with recovery cardiac function in Pakistani CABG patients.

Keyword: Heart rate, rehabilitation, coronary artery bypass grafting, ejection function, cardiac rehabilitation exercise training.

INTRODUCTION

Cardiac rehabilitation (CR) is a program that helps the patients manage their respective diseases through promotion of education and lifetime exercise and is appropriate those with heart attack, angina pectoris, coronary artery bypass graft surgery (CABGS), cardiac arrhythmias and myocardial infarction (MI), balloon angioplasties, and congestive heart failure (CHF). In some cases improvement in cardiac problem was reported. (Horning *et al*., 1996; Linke *et al*., 2001, Hambrecht *et al*., 1995, 1996, 1997; Tyni-lenne *et al*., 1997, 1998) but in most cases failure is reported. (Piepoli *et al*., 1999; Hambrecht *et al*., 1999; Fang *et al*., 2003; Belardielli *et al*., 1999, Afzal *et al*., 1998). As such not very much research data is available in Pakistan population. It is therefore; very pertinent to undertake a prospective study involving degree of improvement in specific cardiac functional variables in patients with CABG following intense, short term exercise training protocols in a clinical set-up, and the information obtained would be of immense help and provide additional guidelines for such patients. Therefore, the present research was carried out on this aspect.

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MATERIALS AND METHODS

Our study population comprised of 100 cardiac patients (57.2±65 years; both sexes) with a recent revascularization procedure who attended the department of Physical Therapy and Rehabilitation for cardiac rehabilitation program between 2008 and 2010. The study was approved by the Ethics Committee of Board of Advanced Studies and Research, University of Karachi. All the subjects gave informed consent and provided medical history Performa which included the risk factors involved.

The patients undertook exercise training program (using Treadmill, Recumbent Bike), keeping in view the Borg's scale of perceived exertion, for 6 weeks. HR and BP were measured. Each patient on getting enrolled for CRET program was given briefing about the details of the program, exercise protocols, instructions for the equipment to follow and particularly about their assessment of their exertion through Rating Perceived Exertion (RPE) scale requested to start the schedule within a week or so reporting to the Physiotherapy Department on individual basis by being punctual and regular without fail and follow the schedule as given below Check-up for Blood Pressure (BP) & Pulse Pressure (PP) Warm up exercise Approximately 5 minutes

of stretching for warm-up, and the session finished with 5 minutes of stretching for cool-down.

Exercise prescription/ intervention

BP and HR measured before exercise & 10-12 minutes after the exercise session. On completion of exercise, two slow rounds for the recovery period.

All patients underwent complete 18 sessions of each type of exercise on daily basis (on treadmill, recumbent bike) under the supervision of physical therapist/exercise physiologist, to help the patient and to monitor the BP, PP, HR and RPE as well as to monitor the therapeutic exercise progress and modify the intensity of the program as needed. Non-availability of the infrastructure and equipment did not allow us to perform cardiac pulmonary exercise test. The patients under study were performing exercise program (designed for individuals) within 3-5 days post surgery as suggested by ACSM guideline for CR centers (2005).

Clinical reassessment was conducted at the end of the CRET program and a record of the study variables for cardiac functional indicators and muscle testing was done so that a degree of improvement is assessed and a comparison can be made between the values observed at the baseline and at the end of the program.

The total duration of a session was approximately 1 hour. The intensity of the aerobic exercise was patient-dependent. The training intensity was increased as tolerated by the patients. HR, BP and exercise intensity were monitored and supervised by a senior cardiopulmonary physical therapist during the exercise session. Statistical formulae were applied to analyze the improvement in cardiac functional indicators. The analyses were performed using the Scientific Package for Social Sciences (version 16; SPSS, Chicago, IL). A p value <0.05 and <0.001 was considered statistically significant.

The relevant statistical methods (t test, paired t test, Pearson correlation and ANOVA) were applied for data analysis to find the changes in the observed and calculated variables between pre and post-CRET in all post-CABG patients, finding correlation between Rating Perceived Exertion (RPE) and cardiac variables, comparing the pre and post-CRET values of these variables between patients with EF >50 % and <50%.

RESULTS

The study was conducted on subjects of both sexes who after CABG surgery were referred to and accepted for the CRET under phase 2 program. The data presented here is on those patients who fully participated in the program without any break strictly following the prescribed schedule and protocol. The data showed an overall mean age of the study participants as 57.2±6.5 years (range; 44-67). In this study 93.2% of total subjects were male and 6.2% female. Majority of patients (n=42; 52.5%) had normal EF and 70% of total patients were physically active more than the rest sedentary ones (table1). The data showed that Post-CRET, mean HR and Systolic Blood Pressure (SBP) values as compared to baseline were found significantly (p=<0.001) lower in both groups with normal or subnormal EF respectively (table2).The calculated values of BP indexes in CABG patients with normal and subnormal EF are given (table3). Compared to the baseline mean values of all the BP indexes calculated found to be significant lower (p<0.001) in the both EF group of Post-CRET except Mean Arterial Pressure (MAP) in subnormal EF group. The two groups in all at the BP indexes showed either negligible or slight decrease both at Pre and Post-CRET. CABG patients with EF >50% and <50% showed significant (p<0.001) improvement in rating at Pre and Post-CRET) respectively. However the improvement in rating was comparatively better for patients with >50% EF (x7) as compared and those with <50% EF (x5). Likewise, there was also improvement in Calf muscle testing (CMT) score at Pre and Post- CRET in CABG patients with EF >50% and <50% respectively. Comparison of these variable between the two CABG groups also shows that both Pre and post-CRET RPE rating and Calf muscle testing score were better for EF with >50% than those with <50% EF .The data is presented in (table 4). In EF (>50%) group, mean exercise prescription of treadmill time (min) and speed (mph) at Post-CRET were significantly higher (p<0.001) compared to the baseline value respectively. Likewise, In EF (<50%) group, mean exercise prescription of treadmill time (min) and speed (mph) at Post-CRET were significant higher (p<0.001) compared to the baseline values respectively. It clearly showed that there was strong tendency towards improvement in treadmill duration (time) and seemed similar in both EF >50% and with <50% EF groups of patients but the improvement in speed was rather higher in the former as compared to the later group of post-CABG patients at post-CRET (table 5).

In EF (>50%) group, mean exercise prescription of Recumbent bike (min) and speed (rpm) at Post-CRET were significant increased (p<0.001) compared to the baseline values respectively. Likewise, In EF <50% group, mean exercise prescription of Recumbent Bike time (min) and speed (rpm) at Post-CRET were significant (p<0.001) increased compared to the baseline values respectively. The data revealed that the improvement in occurred following Recumbent exercise Bike both in time and speed which appeared to be almost in the same range of enhancement in both groups of patients but the improvement in time seemed better than in speed (table 6).

Table 1: Demographic and cardiac function features of CABG patients

Patient characteristics	Frequency*	Percentage
Age (Years)	57.2±6.5	
Female	5	6.2
Male	75	93.8
Pre Exercise Heart (bpm)	86.5±11.6	
Pre Exercise Systolic Blood Pressure Level (mmHg)	120.7±11.6	
Pre Exercise Diastolic Blood Pressure Level (mmHg)	73.2±5.9	
*(Mean± Standard deviation)		

Studied variables in post CABG patients with EF (>50% and <50%) alteration in cardiovascular variables - observed

Table 2: Comparison between pre and post CRET BP indexes in CABG patient (with EF >50 % and <50%)

	Ejection Fraction (>50 %)				Ejection Fraction (<50%)			
BP indexes	Mean	SD	t-statistics	p- value	Mean	SD	t-statistics	p- value
Pre-CRET HR (bpm)	89.71	12.02	8.88	<0.001	83.00	10.30	5.52	<0.001
Post-CRET HR (bpm)	78.14	5.63			76.42	5.05		
Pre-CRET SBP (mmHg)	124.05	11.27	6.68	<0.001	117.11	11.12	4.66	<0.001
Post-CRET SBP (mmHg)	111.67	10.16			109.21	7.84		
Pre-CRET DBP (mmHg)	73.57	6.55	0.13	0.897	72.89	5.15	1.61	0.116
Post-CRET DBP (mmHg)	73.42	6.30			70.73	6.15		

Alteration in cardiovascular variables-calculated

Table 3: Comparison between pre and post CRET BP indexes (MAP, RPP, THR (min), THR (max), PP) in CABG patients (with EF >50 % and <50%)

	Ejection Fraction (>50%)				Ejection Fraction (<50%)			
BP indexes	Mean	SD	t-statistics	p- value	Mean	SD	t-statistics	p- value
Pre-CRET MAP	90.39	6.79	3.90	<0.001	87.63	6.43	3.25	0.02
Post-CRET MAP	86.17	5.56			83.56	5.41		
Pre-CRET RPP	11156.	2001.55	9.48	<0.001	9716.8	1487.13	7.77	<0.001
Post-CRET RPP	8716.4	912.05			8353.9	886.93		
Pre-CRET THR min	133.06	7.16	8.88	<0.001	131.33	6.27	5.52	<0.001
Post-CRET THR min	128.43	4.92			128.70	4.74		
Pre-CRET THR max	151.12	6.24	8.88	<0.001	151.47	6.30	5.52	<0.001
Post-CRET THR max	149.38	5.63			150.48	5.98		
Pre-CRET PP	50.47	10.58	6.565	<0.001	44.21	8.89	3.531	0.001
Post-CRET PP	38.23	11.60			38.47	8.59		

Alteration in rating of perceived exertion and calf muscle testing score

Table 4: Comparison between pre and post CRET rating perceived exertion and calf muscle testing in CABG patients (with EF >50 % and <50%)

	Ejection Fraction (>50%)				Ejection Fraction (<50%)			
Parameter	Mean	SD	t-statistics	p- value	Mean	SD	t-statistics	p-value
Pre-CRET RPE	3.60	1.73	15.53	<0.001	4.26	1.81	16.95	<0.001
Post-CRET RPE	0.53	0.82			0.84	0.85		
Pre-CRET CMT	3.19	0.96	-3.15	0.003	2.92	1.02	-2.55	0.015
Post-CRET CMT	3.83	1.36			3.44	1.05		

DISCUSSION

Exercise therapy as beneficial component of Cardiac Rehabilitation (CR) for heart patient's e.g. post-CABG is increasingly accepted with variety of protocols and guidelines under phase II by professional organizations in most of the developed countries but its applicability in Pakistani healthcare system/hospitals is far less known and practiced. Reports dealing with surgical and procedural modifications for CABG in Pakistan population have appeared in recent years but none on CR effects in cardiac patients particularly post-CABG (Tareen

Alteration in treadmill time and speed

Table 5: Comparison between pre and post CRET exercise prescription treadmill in CABG patients (with EF >50% and <50%)

	Ejection Fraction (>50%)				Ejection Fraction (<50%)			
Parameter	Mean	SD	t-statistics	p- value	Mean	SD	t-statistics	p- value
Exercise Prescription Treadmill Time (min) Pre-CRET	10.16		-121.72	<0.001	10.07	1.17	-24.22	<0.001
Exercise Prescription Treadmill Time (min) Post-CRET	29.71	0.94			28.50	4.80		
Exercise Prescription Treadmill Speed (mph) Pre-CRET	0.84	0.21	-12.35	<0.001	1.15	1.29	-5.71	<0.001
Exercise Prescription Treadmill Speed (mph) Post-CRET	2.68	0.97			2.74	0.60		

Alteration in recumbent bike time and speed

Table 6: Comparison between pre and post CRET exercise prescription recumbent bike in CABG patients (with EF >50 % and <50%)

	Ejection Fraction (>50%)				Ejection Fraction (<50%)			
Parameter	Mean	SD	t-statistics	P- value	Mean	SD	t-statistics	P- value
Recumbent Bike Time (min) Pre-CRET	10.21	0.61	-118.66	<0.001	10.10	1.22	-40.51	<0.001
Recumbent Bike Time (min) Post CRET	29.71	0.94			28.81	3.14		
Recumbent Bike Speed (rpm) Pre-CRET	28.45	3.74	-61.93	<0.001	28.28	3.34	-50.30	<0.001
Recumbent Bike Speed (rpm) Post CRET	58.21	4.53			58.28	5.84		

et al., 2007, Dar *et al*., 2007, 2009, Mir Muhamamd-Sadeghi *et al*., 2008; Iqbal *et al*., 2010, Khan *et al*., 2009, 2010, Hayat *et al*, 2011, Ahmad *et al*., 2011, Naqvi *et al*., 2011). Thus, there complete lack of information regarding the effectiveness of CRET on post-CABG patients in Pakistani socio-cultural set-up which is known to be different from that of western countries warranted the present investigation. One of the major goals of this study was to test the efficacy of simple exercise routines performed during phase 2 of cardiac rehabilitation program. One of the leading causes of recurrence after CABG is low cardiopulmonary endurance of patients. This can be improved by CRET, however, due to the cost of exercise equipment and other patient related factors, the stage 2 program can either not be started in CABG patients or cannot be continued into the third phase (Gray *et al*., 1997; Oldridge *et al*., 1993, Taylor and Kirby, 1997).

Our study is important due to the fact that it shows a relatively simple yet cost effective exercise routine that can be continued at home without special equipment. A randomized controlled trial performed in Italy reported lower costs when they started a home program. The low cost of program incurred was also due to less dependency on health care system (Manchionni *et al*., 2003). We also demonstrated the fact that this exercise protocol increases the VO2max in patients with and without cardiac failure. We measured the blood pressure of subjects before and 10-12 minutes after cardiac rehabilitation exercise program, During the present studies significantly lower values ($p<0.001$) were observed for all the BP indexes (Heart Rate (HR) 16%; Systolic Blood Pressure (SBP) 8.6%; Pulse Pressure (PP) 11%; Rate Pressure product (RPP), 8.8%; Mean Arterial Pressure (MAP) 4.6%; Maximal HR and Target Heart Rate THR -HR max and HR min- with rather lower %) except Diastolic blood pressure (DBP) at post-CRET when compared with those at the baseline. Assessment of blood pressure is an important part of cardiac rehabilitation, where the subjects are categorized according to the Seventh Report of the Joint National Committee (JNC7; Chobanian *et al*., 2003) as well as assessed for orthostatic hypotension. The goal is to reduce the blood pressure to less than 140/90 mmHg. In subjects who are having Coronary artery disease (CAD) as in this study, the goal is to reduce the blood pressure to less than 130/80 mmHg. In case of ventricular systolic dysfunction, this level is further reduced to less than 120/80 mmHg (Rosendoff *et al*., 2007). A new progressive treadmill protocol with reduced initial speed (1.0 mile/h or 1.6 km/h) with the established one was done to determine the comparability and reproducibility of the new protocol with respect to oxygen consumption, HR, minute ventilation, respiratory exchange ratio and BP at peak exercise The new progressive treadmill protocol represents a valid, reliable protocol for patients with arterial claudication. This protocol may be useful for

testing patients with a low functional capacity so that clinically appropriate exercise prescriptions can be established and the efficacy of treatments can be determined (Riebe *et al*., 2001). Significant improvements ($p<0.001$) were observed in HR and SBP post-CRET in patients with either normal (12.8% & 9.9%) or subnormal EF (7.9% & 6.8%) respectively. The pre CRET values of both HR and SBP were 6.7% and 5.6% lower in the group with <50% EF respectively. CABG patients with EF >50% and <50% showed significant ($p<0.001$) improvement in RPE (85% and 80%) at Post-CRET respectively. There was also slight improvement in Calf muscle testing score (20% & and 17%) at Post- CRET patients of both groups. CABG patients with EF >50 % and <50% showed significant ($p<0.001$) improvement in both treadmill time (192% and 182%) and speed (219% and 138%) at post-CRET respectively. Both groups of patients also showed significant ($P<0.001$) improvement in both Recumbent Bike time (190% and 185%) and speed (104% and 106%) at post-CRET respectively though improvement in time was better than in speed. Several studies have examined the association of conventional cardiovascular parameters with exercise capacity and ejection fraction. These include: for example, Alfieri, 1994, Bouchart *et al*., 1997; Trachiotis *et al*., 1998, Haider *et al*., 2003; Lipinsky *et al*., 2005; Dutcher *et al*., 2007, Temporelli *et al*., 2008; Kitzman *et al*., 2010; Edelman *et al*, 2011; Hyakwoski *et al*., 2011; Haddadzadeh *et al*., 2010, 2011; Velaazquez *et al*., 2011; Taylor *et al*., 2012) . Highly significant difference was achieved for RPE between Pre and post-CRET (0.68 vs 3.91) showing that 97% of the post-CABG patients achieved rating <2 of RPE scale at post-CRET, compared to 2-5 in 70%. The rating of perceived exertion, according to modified Borg scale showed a highly significant improvement ($p<0.001$) in our patients with ejection fraction more than 50% as well as less than 50.

In patients with cardiac failure (ejection fraction <50%), the warm up period is extended so as to increase skeletal muscle blood flow before going for the desired intensity level. The exercise intensity is also reduced to the recommended 40% to 60% of the maximal oxygen uptake (Vo2 max). According to the actual Borg scale (Borg, 1982), the rating of perceived exertion should be 10-13. It is seen that the rating of perceived exertion is more reliable indicator of exercise intensity than heart rate response in patients of cardiac failure. This may be due to the underlying patho-physiological aspects keeping the heart rate low or high in patients with cardiac failure, making it an unreliable indicator. Patients who start cardiac rehabilitation program perform exercise at an intensity level 20 beats above their resting heart rate. This was considered equivalent to 11-13 on a Borg's Scale for rating of perceived exertion. A comparative study was done between the two relating each assessment protocol with Vo2 max and a substantial degree of inter subject variability was found (Joo *et al*., 2004). The ratings RPE scale is generally accepted for subjective estimation exercise intensity as well as for its monitoring and regulation across a variety of populations.

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