DOI: *https://doi.org/10.48305/arya.2024.42234.2926*

Is cardiac rehabilitation after PCI as effective as CABG? The first experience from the eastern mediterranean region cardiac rehabilitation registry

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Original Article

Abstract

BACKGROUND: The effectiveness of cardiac rehabilitation (CR) programs following either percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) has been separately studied. Few studies have compared the effects of similar CR programs between PCI and CABG. This study aimed to compare the effects of CR in patients recruited following either PCI or CABG on coronary heart disease risk factors, psychological variables, and functional capacity.

METHODS: For this retrospective study, the documents of the CR program registry of the Isfahan Cardiovascular Research Institute were reviewed from 2008 to 2021. Patients with ischemic heart disease undergoing PCI or CABG were enrolled in an 8-week exercise-based cardiac rehabilitation program. Demographics, smoking status, clinical data, echocardiographic parameters, laboratory data, functional capacity, and psychological status were assessed.

RESULTS: Patients who underwent CABG (n=557) were more likely to be referred to CR than those who underwent PCI (n=440). All variables changed significantly after the CR program compared to their baseline value in both the PCI and CABG groups. However, low-density lipoprotein and total cholesterol levels, peak systolic blood pressure, and resting and peak diastolic blood pressure did not change in any of the groups, and fasting blood sugar (p=0.01) and triglyceride (TG) (p=0.01) levels significantly decreased only in the PCI group. Between-group comparisons indicated that after adjustment, no significant difference was observed between the PCI and CABG groups except for TG, which was significantly reduced in the PCI group (p=0.01).

CONCLUSION: The CR program was equally effective in patients who underwent either PCI or CABG.

Keywords: Cardiac Rehabilitation; Percutaneous Coronary Intervention; Coronary Artery Bypass Grafting; Coronary Heart Diseases; Psychological Factors; Risk Factor

Date of submission: 10/29/2023, ***Date of acceptance:*** 1/9/2024

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Introduction

Cardiovascular diseases, which are the leading cause of death globally, have several modifiable risk factors[1,2] and can be managed and intervened upon by comprehensive exercise-based rehabilitation programs[3]. Cardiac rehabilitation (CR) programs have been introduced to patients following coronary events to facilitate lifestyle changes[4-6]. Indeed, CR has significant positive effects on the functional capacity, lipid profile, glycemic control, echocardiographic indexes, smoking behavior, and blood pressure of patients[6-8]. These programs can also enhance the quality of life, modify psychological factors, and reduce mortality and readmission rates[9,10]. Although CR is highly recommended for all patients with coronary artery disease, referral to and participation in CR is globally low[11-13].

There are extensive studies on the effectiveness of CR after coronary artery bypass grafting (CABG), leading to an accumulation of evidence in favor of CR following this intervention[4]. Revascularization in patients with coronary artery diseases is also treated with less invasive procedures like percutaneous coronary intervention (PCI). Numerous studies have evaluated the impacts of CR in PCI only[10-14]; however, there is a lack of evidence from the Middle-Eastern region in this regard. Furthermore, no study has ever compared the effectiveness of CR after PCI to that of CABG. Therefore, the authors aimed to compare the impact of phase-II comprehensive CR after PCI vs. CABG on coronary heart disease risk factors, psychological variables, and functional capacity of the CR registry in the Eastern Mediterranean region. The authors hypothesize that if the value of CR after PCI is not more than that of CABG, it is not less than that, and both PCI and CABG patients will benefit from CR to an equal magnitude.

Methods

Study design

For this retrospective study, the CR program registry of the Cardiac Rehabilitation Research Center of the Cardiovascular Research Institute (a WHO-collaborating center in EMRO) was searched and reviewed from January 2008 to December 2021. All patients with ischemic heart disease who were admitted for either PCI or CABG were advised to participate in this hospital-based CR program. Before being discharged, an invitation card was given to them, which needed to be validated by their cardiologist or surgeon before participating in the program. The inclusion criteria were all registered patients who had undergone either PCI or CABG for the first time, completed the CR program as scheduled, and answered all the questionnaires. The exclusion criteria included the following: patients with serious medical conditions (e.g., cerebral vascular attacks, chronic kidney disease, cirrhosis, and chronic obstructive sleep apnea), patients who couldn't tolerate physical activity sessions, > 20% missing data in the medical documents or questionnaires, a previous history of PCI or CABG, and missing two or more CR program sessions.

Cardiac rehabilitation program:

CR was recommended to every patient with any indications of CR. This 8-week exercise-based CR program included both physical exercise and educational sessions. The physical exercise sessions were offered three times a week for eight weeks (24 sessions in total) and supervised by a trained sports physician. The eight lecture-based educational sessions for controlling stress, anxiety, and depression, as well as for quitting smoking, were led by a trained psychologist. The sessions on following a healthy lifestyle and nutrition plan were led by a trained dietician. The patients were contacted regularly before their sessions by the center secretary and reminded of the scheduled classes.

Assessments

A checklist of demographic variables (age and sex), smoking status (current, former, and never), physical activity level, laboratory data, cardiac function test results, and psychological status was used at the time of registration (within one week before starting the program), and was repeated within one week of completing the program.

To assess the physical activity level, the Persian validated long-form version of the International Physical Activity Questionnaires (IPAQ) was used[15]. IPAQ is a 7-day recall questionnaire that measures time spent per week on vigorous activity, moderate activity, and walking. Briefly, IPAQ assesses physical activity undertaken across a comprehensive set of domains (work, transportation, housework, and leisure time). Activity is then calculated as the total time (in minutes) spent in three activity categories. The total time in each category is then weighted by a Metabolic Equivalent of Tasks (METs). According to the reported METs, subjects were categorized into three levels of activity: walking, moderate, and vigorous[15].

Fasting blood samples were obtained before starting and after completing the program. All the samples were taken in the central laboratory at the center by the same team. Fasting blood glucose (FBS) and a lipid profile (triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C)) were recorded.

Echocardiography was scheduled for all patients before starting and after completing the CR. All echocardiographies were performed in the left lateral decubitus position with the Philips IE33 ultrasound machine and interpreted by an echocardiologist under standard protocols to obtain the left ventricular ejection fraction (EF)[16].

The computer-controlled treadmill exercise test (Stress Test System, AST-3000, AVECINA Company, Iran) was used to evaluate functional capacity. The resting heart rate (HR), systolic, and diastolic blood pressure (SBP and DBP, respectively) were measured manually under the standard protocol before the exercise by an experienced exercise test room nurse. The intensity of the exercise test was scheduled with the graded multi-stage maximal symptom-limited Bruce protocol[17,18], which was continued until physical exhaustion or serious signs/symptoms occurred. The HR, SBP, and DBP were measured once at every stage, at peak exercise, and twice during the recovery phase. After completion, test duration, cardiorespiratory function in METs (derived from the walking speed and slope), and electrocardiography were extracted from the program. The final result of the exercise test was interpreted by a cardiologist and categorized as positive, negative, or undetermined/unidentifiable.

To assess psychological status, the authors used the validated Persian versions of the questionnaires for anxiety[19], depression[20], general quality of life (QoL)[21], and health-related quality of life (HR-QoL)[22].

Anxiety was evaluated with the 20-item Zung's self-rating anxiety scale (SAS) questionnaire[23] with scores ranging from normal to mild (20-44), moderate (45-59), severe (60-74), and very severe (75 and above).

The level and score of depression were assessed using the Beck depression inventory (second edition) questionnaire (BDI-II), which consists of 21 questions[20] with scores of low (0-10), mild (11-16), moderate (17-30), and high (31 and above).

The SF-36 questionnaire was utilized by the authors to evaluate the general aspects of QoL[21]. This questionnaire has two general domains, namely physical and mental health, each with four subdomains. HR-QoL in cardiac disease was evaluated using the 27-item MacNew questionnaire[22] with questions classified into physical, emotional, and social domains.

Statistical Analysis

The authors carried out all analyses with IBM SPSS software version 20.0. Categorical variables are expressed as numbers and percentages, while quantitative variables are expressed as mean and standard deviation. The Kolmogorov-Smirnov test was used to verify the normality assumption. For quantitative variables, a baseline measurement was assessed by an independent t-test or Mann–Whitney test (if the normality assumption was not met). Categorical variables were compared using the Chi-square test. Bonferroni correction was applied to determine the significance of any differences. Within-group comparisons were assessed by paired t-tests for normally distributed variables or Wilcoxon tests for non-normally distributed variables. Analysis of covariance (ANCOVA) was used to evaluate between-group comparisons. Variables that were significantly different at baseline or were confounders were also adjusted in ANCOVA. If the heterogeneity of variance was not met, a logarithmic transformation was applied. P-values < 0.05 (two-tailed) are considered statistically significant.

Results

The CR program was conducted more frequently following CABG than PCI (n=557 vs. n=440 patients, respectively). Among these patients, male participation was higher than female, but there was no significant difference between the two genders (426 (76.48%) in CABG and 316 (71.81%) in PCI, p=0.1). The authors found that CABG patients were significantly older than the PCI patients (58.94±8.85

vs. 57.72±9.79 years, p= 0.02). 111 documents were excluded from the secondary analysis due to missing data after CR assessments.

CABG participants had significantly higher LDL-C (p<0.0001) and TC (p<0.0001) levels compared to PCI. However, the mean EF (p=0.01), exercise test METs (p=0.019), anxiety (p<0.0001), and depression (p<0.0001) scores were significantly higher in PCI (Table 1).

As shown in Table 2, all variables underwent significant changes after the CR program compared to their baseline value in either the PCI or CABG group. However, LDL-C and TC levels, peak SBP, and resting and peak DBP remained unchanged in all groups. Only in the PCI group did FBS (p=0.01) and TG (p=0.01) levels significantly decrease.

Between-group comparisons, after full adjustment, indicated no significant change after the CR program between the PCI and CABG groups, except for TG (Table 3). The authors observed a significant reduction in TG after the CR program in patients with PCI compared to those with CABG.

Discussion

It is generally believed that CR should be recommended to all patients with cardiovascular disease as a secondary prevention strategy[24]. However, the outcomes of CR have not been compared between PCI and CABG patients in a comprehensive study from an advanced CR center in the Eastern Mediterranean region. The authors' results suggest that both PCI and CABG patients benefited similarly from CR, as the outcomes were not significantly different between the two groups in most examined variables. These data indicate that CR is a highly effective secondary prevention strategy in coronary artery disease patients, and its priority after PCI is as equal as after CABG.

Although the goal of CR is to educate patients about the harmful effects of smoking on the heart, its efficacy is not comparable to explicit smoking cessation programs in addiction treatment centers. More than half of the Portuguese CR participants quit smoking in the follow-up evaluations, and the authors have suggested that CR is a great opportunity to educate patients and emphasize the importance of smoking cessation. In this study, the distribution of smoking status changed significantly before and after CR in each group[25]. This conclusion is in agreement with other studies, but without significant differences between PCI and CABG[26,27].

The positive effect of CR on functional capacity after PCI and CABG has been assessed in many studies, with the vast majority reporting promising effects[28-32], some of which indicated a greater benefit for patients undergoing CABG[29,33,34]. This is likely due to the more extensive surgical procedure with greater postoperative muscle deconditioning than with the less invasive PCI procedure, in which patients can ambulate immediately following the procedure. Therefore, CABG patients have a lower functional capacity at the entry of CR, but this phenomenon is reversible and transient with the aid of CR[29,33], emphasizing the importance of CR after CABG. In this study, the authors found that both groups of patients significantly improved after CR, although no significant difference was found between CABG and PCI in physical activity, left-ventricular EF, treadmill exercise test duration, and METs.

A study on PCI demonstrated that CR positively affected all aspects of the lipid profile level[35] with evidence that lipid profile components significantly decreased with CR following CABG[36]. Although there is a lack of evidence for a link between exercise-based CR and fasting blood sugar (FBS) in patients with PCI[35], it was revealed that FBS and triglycerides (TG) decreased only in the PCI group with high-density lipoprotein cholesterol (HDL-C) increasing in both groups and no change in total cholesterol (TC) and low-density LDL-C with CR. Possible explanations are the worsening of insulin sensitivity by statins[35], patients' nutrition at home, their compliance with dietary recommendations, ethnic differences, the intensity of physical activity, and its duration. Besides, except for TG which was significantly decreased in patients with PCI, CR had the same effect on the lipid profile and FBS of CABG and PCI patients.

Both resting and peak heart rate (HR) significantly changed in both groups with no significantly greater change in favor of CABG or PCI patients. Other studies found a greater change in resting HR in patients with CABG than PCI, perhaps as an indicator of greater parasympathetic tone due to the longer convalescence period after surgery[37]. Nevertheless, as HR-lowering drugs such as beta-blockers are prescribed to lower the heart demand

Table 1. Cardiac rehabilitation participants' baseline characteristics before the program

Variables			Total (n=997)	PCI (n=440)	CABG (n=557)	P
Smoking n, (%)	Never		761 (76.32)	335 (76.13)	426 (76.48)	0.61
	Current		93 (9.32)	45 (10.22)	48 (8.61)	
	Past		143 (14.34)	60 (13.63)	83 (14.9)	
***Physical Activity* (MET.min/week)**						
Walking			2025.87±2141.84	1885.80±2123.94	2212.63±2157.77	0.03
Moderate			1896.29±3832.13	2391.70±4670.37	1235.73±2118.79	<0.0001
Vigorous			1140.09±4322.76	824.88±2551.24	1560.36±5894.96	0.86
Total			9265.11±5367.67	9451.47±5497.35	9016.25±5195.70	0.52
Lab Data						
Fasting Blood Sugar (mg/dL)			111.08±36.63	112.08±40.39	110.30±33.41	0.80
Triglyceride (mg/dL)			165.54±91.49	163.87±90.98	166.85±91.95	0.38
Low-density lipoprotein (mg/dL)			92.85±35.57	86.66±32.26	97.78±37.30	<0.0001
High-density lipoprotein (mg/dL)			39.54±9.19	38.92±8.58	40.03±9.62	0.14
Total cholesterol (mg/dL)			167.03±45.85	160.33±44.43	172.31±46.29	<0.0001
Cardiac Function tests						
Ejection fraction (%)			51.21±11.27	52.02±11.87	50.57±10.73	0.01
Treadmill Exercise stress test	Resting HR (bpm)		79.78±16.03	76.69±15.00	82.23±16.40	<0.0001
	Peak HR (bpm)		125.87±23.85	122.52±23.19	128.53±24.05	<0.0001
	Resting SBP (mmHg)		116.99±17.66	117.07±16.48	116.94±18.57	0.83
	Peak SBP (mmHg)		131.84±22.53	129.35±23.43	133.39±21.85	0.01
	Resting DBP (mmHg)		72.25±10.24	72.72±9.68	71.86±10.67	0.20
	Peak DBP (mmHg)		77.43±10.52	76.84±10.98	77.79±10.23	0.40
	Test Duration (min)		14.41±4.94	14.36±4.64	14.45±5.18	0.67
	METs		8.49±3.06	8.79±3.32	8.25±2.81	0.01
	Result	Negative	700 (70.21)	312 (70.9)	388 (69.65)	0.01[a]
		Positive	100 (10.03)	31 (7.07)	69 (12.38)	
		UD	197 (19.75)	97 (22.04)	100 (17.95)	
Psychological status						
Anxiety Level	Normal -mild		711 (71.31)	288 (65.45)	423 (75.94)	<0.0001[b]
	Moderate		231 (23.16)	123 (27.95)	108 (19.38)	
	Severe		51 (5.11)	26 (5.9)	25 (4.48)	
	Very severe		4 (0.4)	3 (0.68)	1 (0.17)	
Anxiety Score			40.34±10.61	41.89±11.11	39.09±10.02	<0.0001
Depression level	Low		735 (73.72)	293 (66.59)	442 (79.35)	<0.0001[c]
	Mild		118 (11.83)	65 (14.77)	53 (9.51)	
	Intermediate		90 (9.02)	52 (11.81)	38 (6.82)	
	High		54 (5.41)	30 (6.81)	24 (4.30)	
Depression Score			11.19±9.14	12.50±10.06	10.13±8.18	<0.0001
General Quality of life	Physical functioning		59.05±23.33	60.78±24.79	56.96±21.28	0.02
	Role-Health		35.31±37.25	36.92±37.98	33.36±36.31	0.26
	Body pain		63.47±26.24	64.22±26.33	62.56±26.14	0.45
	General health		59.14±19.07	58.95±18.96	59.38±19.22	0.82
	Energy/Fatigue		56.95±22.10	56.45±22.64	57.57±21.45	0.42
	Social functioning		67.46±25.93	68.50±26.36	66.19±25.39	0.18
	Role emotional		53.75±40.93	54.99±41.61	52.24±40.10	0.37
	Emotional Well being		66.11±22.30	66.57±21.79	65.55±22.93	0.64
Health-related Quality of life	Physical		4.75±1.08	4.69±1.10	4.79±1.07	0.28
	Social		4.81±1.08	4.78±1.06	4.84±1.09	0.46
	Emotional		4.75±0.93	4.64±0.86	4.83±0.98	0.01

PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting surgery; UD, undetermined; HR, heart rate;SBP, systolic blood pressure; DBP, diastolic blood pressure

[a] According to Bonferroni method analysis, this significant P value was seen in two situation: when comparing negative group with positive group and when comparing group "other" with positive group.

[b] According to Bonferroni method analysis, this significant P value was seen when comparing the normal-mild group with moderate group.

[c] According to Bonferroni method analysis, this significant P value was seen when comparing group "low" with other groups.

Table 2. Comparison of variables before and after the program in each group

Variables		PCI Before	PCI After	P	CABG Before	CABG After	P
Smoking	Never	335 (76.13)	335 (76.13)	<0.0001[a]	426 (76.48)	426 (76.48)	<0.0001[a]
	Current	45 (10.22)	12 (2.72)		48 (8.61)	16 (2.87)	
	Past	60 (13.63)	93 (21.13)		83 (14.9)	115 (20.64)	
***Physical Activity* (MET.min/week)**							
Walking		1885.80±2123.94	2273.18±1956.64	<0.0001	2212.63±2157.77	3094.22±2797.82	<0.0001
Moderate		2391.70±4670.37	3399.20±3059.22	<0.0001	1235.73±2118.79	3080.00±3686.04	<0.0001
Vigorous		824.88±2551.24	2346.86±9522.90	<0.0001	1560.36±5894.96	1293.04±4097.96	0.16
Total		9451.47±5497.35	11179.09±5078.57	<0.0001	9016.25±5195.70	11218.78±5275.16	<0.0001
Lad Data							
Fasting Blood Sugar (mg/dL)		112.08±40.39	107.31±30.56	0.01	110.30±33.41	108.97±33.44	0.84
Triglyceride (mg/dL)		163.87±90.98	144.94±65.72	0.01	166.85±91.95	156.97±76.48	0.66
Low-density lipoprotein (mg/dL)		86.66±32.26	84.48±27.30	0.81	97.78±37.30	94.38±31.69	0.37
High-density lipoprotein (mg/dL)		38.92±8.58	39.89±10.46	0.03	40.03±9.62	41.41±9.77	0.01
Total cholesterol (mg/dL)		160.33±44.43	154.68±36.03	0.26	172.31±46.29	167.50±37.84	0.44
Cardiac Function tests							
Ejection fraction (%)		52.02±11.87	53.79±10.51	<0.0001	50.57±10.73	53.96±9.59	<0.0001
Treadmill Exercise stress test	Resting HR (bpm)	76.69±15.00	74.47±14.42	0.02	82.23±16.40	77.13±15.84	<0.0001
	Peak HR (bpm)	122.52±23.19	131.36±23.68	<0.0001	128.53±24.05	130.03±24.12	0.01
	Resting SBP (mmHg)	117.07±16.48	113.70±16.12	0.02	116.94±18.57	116.05±17.02	0.04
	Peak SBP (mmHg)	129.35±23.43	129.35±21.49	0.85	133.39±21.85	134.68±25.45	0.53
	Resting DBP (mmHg)	72.72±9.68	71.42±9.05	0.48	71.86±10.67	72.11±9.97	0.20
	Peak DBP (mmHg)	76.84±10.98	76.82±10.41	0.47	77.79±10.23	78.42±15.13	0.13
	Test Duration (min)	14.36±4.64	18.09±4.95	<0.0001	14.45±5.18	17.73±4.76	<0.0001
	METs	8.79±3.32	11.93±3.70	<0.0001	8.25±2.81	10.90±3.07	<0.0001
	Result Negative	312 (70.9)	379 (86.13)	<0.0001[b]	388 (69.65)	474 (85.09)	<0.0001[b]
	Result Positive	31 (7.07)	16 (3.63)		69 (12.38)	20 (3.59)	
	Result UD	97 (22.04)	45 (10.22)		100 (17.95)	63 (11.31)	
Psychological status							
Anxiety Level	Normal -mild	288 (65.45)	342 (77.72)	<0.0001[c]	423 (75.94)	459 (82.4)	<0.0001[c]
	Moderate	123 (27.95)	83 (18.86)		108 (19.38)	93 (16.69)	
	Severe	26 (5.9)	15 (3.4)		25 (4.48)	5 (0.89)	
	Very severe	3 (0.68)	0 (0)		1 (0.17)	0 (0)	
Anxiety Score		41.89±11.11	39.72±11.13	<0.0001	39.09±10.02	38.02±9.78	0.000
Depression level	Low	293 (66.59)	357 (81.13)	<0.0001[d]	442 (79.35)	496 (89.04)	<0.0001[d]
	Mild	65 (14.77)	43 (9.77)		53 (9.51)	27 (4.84)	
	Intermediate	52 (11.81)	29 (6.59)		38 (6.82)	25 (4.48)	
	High	30 (6.81)	11 (2.5)		24 (4.30)	9 (1.61)	
Depression Score		12.50±10.06	10.31±9.16	<0.0001	10.13±8.18	8.18±7.34	<0.0001
General Quality of life	Physical functioning	60.78±24.79	70.16±20.86	<0.0001	56.96±21.28	68.13±20.93	<0.0001
	Role-Health	36.92±37.98	55.43±39.35	<0.0001	33.36±36.31	51.03±38.60	<0.0001
	Body pain	64.22±26.33	74.39±22.80	<0.0001	62.56±26.14	73.58±21.67	<0.0001
	General health	58.95±18.96	64.03±18.74	<0.0001	59.38±19.22	64.38±17.82	<0.0001
	Energy/Fatigue	56.45±22.64	64.16±20.19	<0.0001	57.57±21.45	62.65±20.56	<0.0001
	Social functioning	68.50±26.36	77.60±22.02	<0.0001	66.19±25.39	76.21±22.63	<0.0001

Continued Table 2. Comparison of variables before and after the program in each group

Variables		PCI Before	After	P	CABG Before	After	P
	Role emotional	54.99±41.61	64.86±38.30	<0.0001	52.24±40.10	64.66±37.56	<0.0001
	Emotional Well-being	66.57±21.79	71.77±19.56	<0.0001	65.55±22.93	69.74±21.04	<0.0001
Health related Quality of life	Physical	4.69±1.10	5.25±1.00	<0.0001	4.79±1.07	5.27±0.93	<0.0001
	Social	4.78±1.06	5.35±1.01	<0.0001	4.84±1.09	5.38±0.96	<0.0001
	Emotional	4.64±0.86	4.88±0.80	<0.0001	4.83±0.98	5.07±0.86	<0.0001

PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting surgery; UD, undetermined; HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure

[a] Bonferroni correction showed significant difference when comparing the "never" group with either "smoker" or "past" group.

[b] Bonferroni correction showed significant difference when comparing the "negative" group with either "positive" or "other" group.

[c] Bonferroni correction showed significant difference when comparing the "normal-mild" group with either "moderate" or "severe" group.

[d] Bonferroni correction showed significant difference when comparing the "low" group with either "mild", "intermediate" or, "high" group.

Table 3. Comparison of delta difference of each variable between the groups

Variables		Total	PCI [After-Before]	CABG [After-Before]	P*
Quit Smoking n, (%)		65 (6.5)	33 (7.5)	32 (5.7)	0.10
***Physical Activity* (MET.min/week)**					
Walking		536.37±2672.43	287.84±2533.96	834.62±2810.94	0.15[a]
Moderate		1421.28±4710.96	1054.29±5385.52	1861.66±3718.88	0.86
Vigorous		964.85±7651.86	1533.70±9422.53	282.24±4672.63	0.26
Total		2117.79±6696.30	1995.71±6610.77	2262.70±6820.68	0.58
Lab Data					
Fasting Blood Sugar (mg/dL)		-2.66±28.48	-4.81±28.64	-0.88±28.26	0.31
Triglyceride (mg/dL)		-7.96±74.78	-11.76±61.54	-4.81±84.12	0.01[a]
Low-density lipoprotein (mg/dL)		-1.26±30.88	-0.47±27.43	-1.92±33.54	0.37
High-density lipoprotein (mg/dL)		1.01±9.11	1.01±8.13	1.01±9.86	0.85
Total cholesterol (mg/dL)		-2.57±38.10	-3.48±37.13	-1.82±38.92	0.11
Cardiac Function tests					
Ejection fraction (%)		2.51±6.74	2.03±6.47	2.93±6.94	0.14
Treadmill Exercise stress test	Resting HR (bpm)	-3.31±14.42	-1.95±14.87	-4.46±13.95	0.12
	Peak HR (bpm)	5.83±23.83	8.96±25.74	3.15±21.75	0.06
	Resting SBP (mmHg)	-2.30±17.96	-2.60±16.60	-2.04±19.04	0.31
	Peak SBP (mmHg)	1.03±22.37	0.01±21.97	1.70±22.64	0.81
	Resting DBP (mmHg)	-0.70±10.73	-0.66±10.71	-0.73±10.77	0.27
	Peak DBP (mmHg)	1.30±14.31	1.42±13.02	1.22±15.12	0.34
	Test Duration (min)	3.52±4.41	3.53±4.28	3.51±4.53	0.27
	METs	2.73±2.64	2.98±2.89	2.53±2.39	0.98
	Get Negative result n, (%)	153 (15.34)	67 (15.22)	86 (15.43)	0.72
Psychological status					
Anxiety Score		-1.99±8.31	-2.24±9.11	-1.78±7.57	0.57
Depression Score		-2.04±6.54	-1.71±6.63	-2.30±6.45	0.29
General Quality of Life	Physical functioning	10.07±22.62	10.58±22.65	9.49±22.64	0.60
	Role-Health	18.74±43.96	20.23±44.55	17.03±43.32	0.22
	Body pain	9.90±25.56	9.59±24.95	10.26±26.29	0.09
	General health	3.96±17.88	4.00±17.02	3.91±18.85	0.56
	Energy/Fatigue	5.71±19.35	7.30±18.07	3.89±20.59	0.19
	Social functioning	8.13±24.29	8.67±22.25	7.52±26.45	0.40[a]
	Role emotional	11.45±47.55	11.93±45.95	10.91±49.42	0.97
	Emotional Well being	3.82±18.34	4.42±17.27	3.14±19.51	0.63
Health related Quality of Life	Physical	0.46±0.86	0.48±0.86	0.45±0.86	0.58
	Social	0.51±0.90	0.52±0.8	0.51±0.92	0.42
	Emotional	0.22±0.76	0.22±0.74	0.22±0.78	0.33[a]

PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting surgery; HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure

*All p-values were obtained by ANCOVA, except for quit smoking obtained by Logistic regression.

[a] Based on logarithmic transformation due to heterogeneity of variance.

after any coronary events, therefore, HR change will be under drug control rather than a CR response.

Resting systolic blood pressure (SBP) decreased significantly and equally in both groups, however, diastolic blood pressure (DBP) and peak SBP were not affected by CR. Although some studies support the authors' findings that exercise-based CR does not influence blood pressure (BP) in patients with either PCI or CABG,[37,38] it was suggested that CABG patients had significantly lower peak DBP as well as resting and peak SBP in comparison with the group without CR[39] and CR participants after PCI had significantly lower SBP and DBP[35]. These hemodynamic contradictions can be due to different exercise protocols with various intensities, age and gender differences, sample size variations, and medications after each procedure[39].

Improvement in controlling anxiety and depression, along with enhanced general quality of life (QoL) and health-related quality of life (HR-QoL), are among the established outcomes of the CR program[40-42] and were observed in the present study. However, no significant difference was found between the two intervention groups. Additionally, it has been shown that patients who underwent PCI have better HR-QoL in the short-term following CR than those who underwent CABG[43]. Furthermore, it was suggested that, in contrast to the CABG patients, PCI patients would have better HR-QoL after the intervention and before the CR, suggesting that greater improvement may be observed in CABG than in PCI[44]. Although it remains controversial, these findings are linked to possible confounding factors like age, sex, socioeconomic status, education level, body weight, and comorbid disease[43,45].

This study could have been limited by the fact that medical documents of one CR referral center were reviewed, and socioeconomic status, educational level, and logistic factors were not evaluated. According to the authors' observation, although CR is advised after both PCI and CABG, more CABG patients participated due to the low PCI referral rate. Moreover, the retrospective nature of the study should be taken into account.

Conclusion

Both PCI and CABG patients from the Eastern Mediterranean region benefit significantly, and to the same extent, from CR. Therefore, it indicates that CR should be supported by the healthcare insurances, noticed by policymakers, and recommended by the physician to both groups.

Acknowledgment

We express our gratitude toward Professor of Emeritus Dr. Neil Oldridge for his kind help, Isfahan Cardiovascular Research Institute, and Cardiac Rehabilitation Research Center staff, and finally Mr. Amirsalar Moazen Safaei for his technical notes through the manuscript.

Conflict of Interest

All authors declare no potential conflict of interest.

Funding

The present research was supported by the Research Council of Isfahan University of Medical Science as a medical student thesis [number: 398216] and did not receive any grants from non-profit organizations and funding agencies in the public and commercial sectors.

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How to cite this article: Sadeghi M, Sheikhbahaei E, Hansen D, Hassannejad R, Rouhani S, Hadavi MM, et al. **Is cardiac rehabilitation after PCI as effective as CABG? The first experience from the eastern mediterranean region cardiac rehabilitation registry.** ARYA Atheroscler. 2024; 20(1): 9-19.