Med. J. Cairo Univ., Vol. 90, No. 5, September: 1451-1457, 2022
www.medicaljournalofcairouniversity.net

Evaluation of the Impact of Cardiac Rehabilitation Program on Post-MI Patients, Egyptian Experience

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Abstract

Background: Cardiac rehabilitation (CR) is a preventive multidisciplinary program, designed to help patients regain their physical, social and psychological functioning. Studies show that the control of risk factors can slow down or even reverse the advancement of the atherosclerosis process, diminishing the morbidity and mortality burden. Participation in cardiac rehabilitationincreases the rate of return to work (1) and reduces medical costs due to decreased rates of re-hospitalizations (1) and PCI procedures (2).

Aim of Study: To assess the effect of a 12-week cardiac rehabilitation program on ischemic patients following myocardial infarction (MI).

Patients and Methods: This is a prospective single-center study that was conducted on 30 patients who survived myocardial infarction with and preserved ejection fraction and in absence of overt heart failure symptoms. A full history and careful physical examination were performed before and after enrollment in a 3-month-cardiac rehabilitation program which prescribed exercise training, 3 sessions/week. The following measurements were taken; weight, BMI, blood pressure and heart rate, in addition to blood samples to assess lipid profile, fasting blood sugar and HbA1c. A primary endpoint of this study was to assess the effect of cardiac rehabilitation program on CV risk factors whereas the secondary endpoint was to evaluate the effect of the programon (MACE), functional capacity and quality of life using the Short-Form 12 (SF-12).

Results: There was a highly significant decrease in systolic, diastolic blood pressure and resting heart rate (p=0.00, p=0.000 and p=0.025 respectively) in addition to total cholesterol, LDL, blood sugar levels and HbA1c (p=0.05, 0.02, 0.006 and 0.015 respectively).

However, there was no statistically significant reduction in Triglycerides, HDL, BMI, and weight. Additionally, a significant improvement in the functional capacityand the health related quality of life (using SF-12) were noted. No major adverse cardiac events were observed until program completion.

Conclusion: Post-MI patients who were referred to a 12-week-exercise-based, comprehensive cardiac rehabilitation program demonstrated improvement in exercise capacity, blood pressure, resting HR, LDL, total cholesterol, cardiac events, psycho-social functioning with 93.3% resumption of work.

Key Words: *Cardiac rehabilitation – Post MI – Ischemic patients – Qol – Exercise tolerance – MACE.*

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Introduction

CARDIOVASCULAR disease (CVD) is a critical health issue in Egypt, causing 39% of all deaths, with significant prevalence of risk factors among the Egyptian population. The growing rates of CVD are translating not only to the direct health care cost, but are also reducing the economic productivity by removing people from the active workforce, which constitutes a major challenge for development. The problem becomes more complex in developing countries such as Egypt, where patients' standard of living and poor health literacy are significant barriers to their risk-factor modification, and compliance to medications. Therefore, patients who developed MI are in need of a rehabilitation service to help them control their risk factors, and return to their prior activity levels **[3]**. Meta analyses show that cardiac rehabilitation programs reduce mortality **[4]**, improve quality of life **[2]**, exercise tolerance, risk factors as well as the overall psychosocial wellbeing **[5]**. Besides being clinically effective it is also a highly cost-effective intervention, compared to other lines of treatment. It reduces health cost related to repeated hospitalization and coronary interventions/surgeries as well as cost related to withdrawal from the workforce due to disability or mortality.

Aim of the work: To evaluate the effect of a 3-month, hospital-based cardiac rehabilitation program on patients following STEMI/ NSTEMI myocardial infarction.

Patient selection: This is a prospective study performed at Ain Shams University Hospital in 2009/2010. Thirty consecutive patients who survived STEMI or NSTEMI without symptoms or signs of overt heart failure were referred to a 3-month hospital-based, exercise training program, 2-3 weeks following the infarction.

This study excluded the following: Patients who had incapacitating, advanced or terminal medical illness, patients with recent acute medical condition (such as stroke, TIAs, myocarditis), patients with contraindication to exercise, patients with CRT or ICDand patients who were referred for CABG.

Patients and Methods

All patients were enrolled in a cardiac rehabilitation program which encompassed:

Medical evaluation: All patients were subjected to meticulous history taking screening forsmoking, hypertension, DM, hyperlipidemia, obesity and prior PCI/CABG. Careful physical examination was performed including weight, body mass index (BMI), resting pulse and blood pressure, signs of heart failure and cardiac murmurs. 2D echocardiography was conducted to evaluate LVEF using biplane Simpson's method.

This is a prospective study preformed at Ain Shams University Hospital in 2009-2010.

A supervised moderate-intensity exercise Program: After explaining the program components to patients and obtaining their written consent, patients were exercised 3 times weekly over 3 months. Exercise prescription targeted achieving a heart rate of 40-60% of the heart rate reserve which was calculated from a prior symptom-limited modified Bruce protocol stress test. Each session lasted for 30min and was preceded by 5min of warm-up exercise. Exercise intensity was guided by Borg scale of rate of perceived exertion (RPE) **[6]** aiming an RPE of 11-13 in the absence of symptoms. A trained cardiac rehabilitation nurse monitored the patient' heart rate, blood pressure and symptoms throughout the sessions.

Risk factor modification: Besides optimization of medical treatment, all patients were subjected to intensive education and counseling conducted by a trained nurse and motivational educational videos. Mean blood pressure values, plasma lipids, fasting blood sugars and glycated Hb were measured before and after completion of the program. Weight management was performed. Obese patients whose BMI ≥30kg/m^2 were advised to reduce their daily caloric requirement by 500 calories while those with BMI ≥25 and ≤30kg/m^2 were encouraged to consider. Patients were educated and counseled to include less saturated fat intake and more fish, grains, fruits and vegetables in their diet.

Major adverse cardiac events including: Death, recurrent MI and/or hospitalization for angina, coronary angiography or re-PCI were recorded in relation to stage fulfilled at cardiac rehabilitation program.

Psychosocial management: Psychological education and counseling was provided via a trained nurse. Evaluation was done through a 12-item Short-Form Health Survey-version 2 (SF-12v2) **[7]**, a self-report of physical and mental health through 8 health dimensions: Physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional health, and mental health. The higher the scores, the better the physical and mental health functioning **[7]**. A cut off of ≤50 in the physical component (PCS-12) is indicative of a physical condition; while ≤42 in mental component (MCS-12) may indicate clinical depression **[7]**.

Functional Capacity was assessed by looking at the distance covered, Borg rate of perceived exertion and resting heart rate before and after completing the program.

The patients reported the duration and rate of their physical activities prior to, during and after completing the CR program. According to their activity levels, patients were classified into: Very active (≥3 times/week for at least 20min per time), moderately active (1-3 times/week for at least 20 min per time) or sedentary (<20min, once a week) **[8]**.

Resumption of work: The ability of patients to resume work without assistance or need for modification.

Statistics:

The results of this study were calculated, tabulated and statistically analyzed. We used Independent student's *t*-test & Mann-Whitney's U test. Pearson's correlation coefficient was calculated to estimate association between numerical variables. Statistically significant results were defined as a *p*-value <.05.

Results

A total of 30 patients completed the exercise training program. The baseline Demographic data and risk factors are shown in Table (1).

Table (1).

Gender:	
Male	22 (73.3%)
Female	8 (26.7%)
Age (years)	35-73
[Range - Mean ± SD]	56.07±8.921
Dyslipidemia*	13 (43.33%)
Treatment for dyslipidemia	13 (100%)
Total Cholesterol (mg/dl):	
Range	100-382
Mean ± SD	199.2±58.96
LDL (mg/dl):	
Range	47-308
Mean ± SD	126.58±48.74
HDL (mg/dl):	
Range	27-79
Mean ± SD	44.9±11.48
TG (mg/dl):	
Range	38-500
Mean ± SD	150.3±99.59
HTN**	12 (40%)
Treatment for HTN	12 (40%)
SBP (mmHg) Range	90-220
Mean ± SD	131±23.976
DBP (mmHg)	60-110
Mean ± SD	82.33±9.714
DM#	10 (33.33%)
Treatment for DM	10 (100%)
FBS (mg/dl) Range	119-420
Mean ± SD	260.77±89.115
HbA1c (%) Range	5.7-11.4
Mean ± SD	7.377±1.9984
Non-smokers	2 (6.6%)
Current Smokers	13 (43.3%)
Former smokers	15 (50%)
Duration (years) Range	15-50
Mean ± SD	32.76±10.44
Obese ^	17 (56.6%)
Weight (kg) Range	67-112
Mean ± SD	86.6±10.928
BMI (kg/m^2) Range	25.31-43.28
Mean ± SD	32.4991±5.11
STEMI	14 (46.7%)
NSTEMI	16 (53.3%)
PCI	29 (96.7%)
CABG	0
Total Revascularization	17 (56.7%)

No = Number.
SD = Standard deviation.
BMI = Body mass index.
DM = Diabetes mellitus.
HTN = Hypertension.
SBP = Systolic blood pressure.
DBP = Diastolic Blood Pressure.
LDL= Low Density Lipoprotein.
HDL=High Density Lipoprotein.
TG= Triglycerides.
STEMI= ST elevation myocardial infarction.
NSTEMI= Non ST elevation myocardial infarction.
PCI= Percutaneous coronary intervention.
CABG= Coronary artery bypass graft.
*Dyslipidemia (LDL.100).
**HTN (BP >140/90), #DM (HbA1c >6.5), ^Obese (BMI ≥30kg/m^2).

1- *Effect of CRP on risk factors:*

After completing the CRP, significant reductions were observed in SBP (131±23.97mmHg to 114±8.137mmHg, $p<0.001$), DBP (82.33± 5.374mmHg to 72.5±7.42mmHg, $p<0.000$), serum LDL (126.58±48.74mg/dl to 75.03±29.13mg/dl, $p=0.02$), and Serum Total cholesterol (199.2± 58.96mg/dl to 150.9±35.17mg/dl, $p=.05$). The mean fasting blood sugar value fell from 260.77± 89.115mg/dl to 170±59.741mg/dl ($p=.006$) and HbA1c level (7.377±1.99g/dl to 6.113±1.2293%, $p<0.015$). Non-significant reductions were noted in serum HDL (44.9±11.48mg/dl to 47.53± 11.59mg/dl, $p=0.38$), serum triglycerides (150.3± 99.59mg/dl to 141.97±76.43mg/dl, $p=0.7$), BMI ($32.49±5.11kg/m^2$ to $32.14±5.03kg/m^2$, $p<0.78$) and weight (86.6±10.92mmHg to 85.67±10.88 mmHg, $p<0.74$).

II- *Secondary endpoints:*

MACE: At 3 months none of the patients died or suffered a myocardial infarction. None underwent Re- PCI or CABG or was hospitalized.

Psycho-social well-being: The SF-12 scores are included in Table (4). Prior to CRP, women showed scores that were lower than their counterparts in the general population. After completing CRP, the scores increased in the categories of bodily pain, physical function and role limitation due to physical problems. Men showed near-normal values in the following sections: Energy/vitality, general health, mental health and physical function; but lower in the others. All men's items improved significantly after CRP completion at 3 months except general health (baseline value was near-normal). When compared to the general population, men showed a significant improvement in both elements (physical role: from 28.7 at baseline to 50.4 after 3 months), and emotional role (from 41.3 to 52.3), $p<0.001$ & $p<0.01$ respectively.

Evaluating Changes in Functional Capacity: Upon completion of the CRP, most patients could exercise 40 minutes at 4.7 mph twice a week and performed other recreational activities 2-3 times a week. Moreover, most patients showed a reduction in their resting heart rate, thus an increase in their heart rate reserve, and exercise tolerance as shown in Table (4).

Evaluating changes in physical activity levels:

Resumption of Work: Most patients were able to resume their work upon completion of CRP: 28 (93.33%) compared to 18 patients (60%) upon enrollment ($p=0.039$).

Table (2): Comparison between baseline and post CRP Data.

	Minimum	Maximum	Mean	Std. Deviation	F	Sig.
SBP:						
Baseline	90	220	131.00	23.976	13.525	.001
Post CRP	90	130	114.00	8.137		
Total	90	220	122.50	19.712		
DBP:						
Baseline	60	110	82.33	9.714	23.537	.000
Post CRP	60	85	72.50	5.374		
Total	60	110	77.42	9.228		
FBS:						
Baseline	119	420	260.77	89.115	9.195	.006
Post CRP	97	295	170.54	59.741		
HA1c:						
Baseline	5.7	11.4	7.377	1.9984	6.913	.015
Post CRP	5.04	9.18	6.113	1.2293		
WT:						
Baseline	67	112	86.60	10.928	.110	.742
Post CRP	65	110	85.67	10.889		(NS)
BMI:						
Baseline	25.31	43.28	32.4991	5.11522	.075	.786
Post CRP	25.31	43.28	32.1408	5.03824		(NS)
Chol:						
Baseline	100	382	199.20	58.966	3.758	.057
Post CRP	96	229	150.90	35.175		
LDL:						
Baseline	47	308	126.58	48.748	5.605	.021
Post CRP	36	167	75.03	29.133		
HDL:						
Baseline	27	79	44.90	11.484	.781	.380
Post CRP	32	80	47.53	11.596		
TG:						
Baseline	38	500	150.30	99.593	.132	.717
Post CRP	50	426	141.97	76.432		

Wt = Weight. Chol = Cholesterol.

Table (3): While women's score improved in the physical role only (16.5-37.5), $p<0.01$.

SF domains	Normal values	Baseline	3 months later
Bodily pain	M (67.5)	61.1	74.6 (*p<0.0001)
	F (59.1)	45.2	56.9 (*p=0.0052)
Energy/vitality	M (59.3)	56.84	62.1 (*p=0.0005)
	F (51.7)	46.3	52.5
General health	M (55.4)	54.6	55.4
	F (48.7)	45.8	46.4
Mental health	M (64.7)	65.8	69.7 (*p=0.012)
	F (57.1)	56.6	57.1
Physical function	M (71.7)	71.5	78.1 (*p=0.0025)
	F (63.9)	46.1	55.9 (*p=0.010)
Role: emotional	M (73.5)	41.3	52.3 (*p=0.004)
	F (68.1)	38.6	46.2
Role: physical	M (65.9)	28.7	50.4 (*p<0.0001)
	F (55.5)	16.5	37.5 (*p=0.002)
Social function	M (75.8)	62.9	72.9 (*p<0.0001)
	F (70.6)	57.7	65.3

Table (4): Functional capacity assessment (Baseline & Post CRP).

Assessment	Baseline	Post CRP	p-value
Distance	5 min at 2mph	40 min at 4.7 mph twice a week	
Borg Rate of Perceived Exertion	10	13	
Resting Heart rate (mean value) bpm	75±11.1s	69±8.9	p=0.025

Table (5): Physical activity (Baseline and Post CRP).

Exercise habits	Upon enrolment	At follow-up	p-value
Sedentary (%)	60%	30%	0.039
Moderately active (%)	26%	42%	
Very active (%)	14%	28%	

Discussion

This study aimed to study the impact of cardiac rehabilitation program on improving cardiovascular risk factors, MACE, functional capacity and quality of life of patients with CAD.

Effect of CRP on CV risk factors:

Results showed a highly significant reduction in in SBP (131±23.97mmHg to 114±8.137mmHg, $p<0.001$) and DBP (82.33±5.374mmHg to 72.5± 7.42mmHg, $p<0.000$), which agrees with Sarrafzadegan et al. **[9]**, Philippe et al. **[10]** and Parvand et al. **[11]**. This significant reduction in blood pressure is likely a collective effect of exercise, healthy eating, and patient motivation to adhere to medications. Improvement in CV risk factors can contribute significantly to thereduction of events in the secondary prevention of coronary disease **[12]**.

Regarding lipid profile, a significant reduction in TC and LDL only was noted. The baseline TG was near normal). This was in agreement with Fard et al. **[13]** who reported a reduction up to normalization in TC, TG, and LDL of (35%, 30% and 38% respectively) in a cohort of 120 patients after only 8 sessions of CR. However, they reported an increase in serum HDLof 5mg/dl vs control ($p<0.05$) mostly due to the larger sample size. This also agrees with Lavie et al. **[14]** who observed similar results in 237 patients and deduced that corresponding dyslipidemic baseline values of LDL, HDL and TG were the strongest predictors of improvement. However other studies **[15,16]** demonstrated significant elevation in HDL-C but stationary TG. The observed improvement in lipid profile may be a combination of multiple variables such as diet, exercise, statins and compliance to treatment. Further studies including control groups are recommended. Moreover, both mean fasting blood sugar and HbA1c levels showed a significant reduction from 260.77±89.115mg/dl to 170±59.741 mg/dl ($p=.006$) and (7.377±1.99g/dl to 6.113± 1.2293 %, $p<0.015$ respectively. This was congruent with Toste et al. **[17]** who studied 253 diabetic patients diagnosed with ischemic heart disease and found a highly significant reduction (<0.001) in their FBS and HbA1C after 3 months of CRP. Patients' weight and BMI did not change significantly. We recommend this to be studied further in larger subsets of patients with longer follow-up periods.

Effect of CRP on MACE:

Our study shows that no major adverse cardiac events was observed up to 3 months of enrollment. This is in line with the metanalysis **[18]** that included 25 studies with 55 035 participants that found that MACE risk was significantly lower in patients who completed cardiac rehabilitation compared to those who did not. (RR=0.49; 95% CI=0.44 to 0.55; $p<0.05$).

Effect of CRP on psycho-social well-being:

The patients' functional capacity and quality of life significantly improved as shown by the SF12 scores. Our findings agree with Dibben G et al. **[19]** who reviewed 84 trials with 23,172 participants primarily after MI and found that there was evidence that exercise-based CRP may improve the health related quality of life using (SF-36) across the following subsets (mental component, physical functioning, physical performance, general health, vitality, social functioning and mental health scores) extending up to one year.

Furthermore, men demonstrated a significant improvement in both physical and emotional dimensions (28.7 to 50.4 after 3 months, $p<0.001$ and 41.3 to 52.3, $p<0.01$ respectively), while women showed improvement in the physical dimension (16.5-37.5, $p<0.01$).

Our patients demonstrated improved exercise tolerance demonstrated by the distance covered, the Borg rate of perceived exertion, and increase in recreational activities through the week. This comes in agreement with Smart et al. **[22]** who reported a significant improvement ($p=0.04$) in exercise tolerance up to 6 months in 483 ischemic patients with atrial fibrillation who completed CRP (vs 476 controls) in metanalysis of nine randomized trials. As a result of this symptomatic improvement, the numbers of patients who became moderately active increased by 61.9%, those who became very active doubled while the number of sedentary patients was halved (26% to 42%), (14% to 28%), and (60% to 30%) respectively ($p=0.03$).

Overall, 93.3% of patients were comfortable to resume their jobs after 3 months of rehabilitation compared to 60% upon enrollment. This agrees with Sun et al. **[23]** who found that after 12 weeks of CR, 87.5% (n=49) of the patients resumed their pre-infarction jobs. Age, sex, education level, smoking history, DM, hospital re-admission, and social support, were significantly related to returning to work after 12 weeks.

Conclusion:

This study showed that a cardiac rehabilitation program including 3 sessions of exercise training weekly for 3 months with ancillary patient education, counseling and psychosocial management improved patients' exercise capacity, blood pres-

sure, resting HR, LDL, total cholesterol, major adverse cardiac events and psycho-social functioning. Cardiac rehabilitation is an effective and efficient intervention for post-MI patients.

Limitations to this study include single center, with small number of patients and short follow-up period. We recommend longer follow-up for cardiac events.

Conflicts of interest: The authors had no conflict of interest.

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تقييم تأثير برنامج إعادة التأهيل القلبى على مريض ما بعد احتشاء عضلة القلب

إن إعادة تأهيل القلب هو برنامج وقائى متعدد التخصصات، مصمم لمساعدة المرضى على استعادة وظائفهم الجسدية والاجتماعية والنفسية. تشير الدراسات إلى أن التحكم فى عوامل الخطر يمكن أن يبطئ أو حتى يعكس تقدم تصلب الشرايين الأساسى، مما يقلل من معدلات المضاعفات والوفيات. تشير الدراسات إلى أن المشاركة فى إعادة تأهيل القلب تزيد من معدل العودة إلى العمل وتقلل من التكاليف الطبية بسبب انخفاض معدلات إعادة المضاعفات التى تستدعى دخول المستشفى أو عمل قسطرة تداخلية.

الهدف من العمل : لتقييم تأثير برنامج إعادة تأهيل القلب لمدة ١٢ أسبوعاً على مرضى قصور الشرايين التاجية بعد احتشاء عضلة القلب.

طريقة الدراسة : شملت هذه الدراسة ٣٠ مريضاً نجوا من احتشاء عضلة القلب بدون أعراض ضعف عضلة القلب. تم أخذ تاريخ طبى دقيق وفحص بدنى كامل قبل وبعد التسجيل فى برنامج إعادة تأهيل القلب لمدة ٣ أشهر والذى تضمن على تدريب رياضى، ٣ جلسات / أسبوع. تم أخذ القياسات التالية، الوزن، ومؤشر كتلة الجسم، وضغط الدم و معدل ضربات القلب، بالإضافة إلى عينات الدم لتقييم مستوى الدهون، وسكر الدم الصائم والهيموغلوبين السكرى كانت نقطة النهاية الأولية هى تقييم تأثير برنامج إعادة تأهيل القلب على عوامل خطر السيرة الذاتية، وكانت نقطة النهاية الثانوية هى تقييم تأثير البرنامج على الأحداث القلبية السلبية الكبرى، والقدرة الوظيفية ونوعية الحياة باستخدام النموذج القصير.

النتائج : وجدنا انخفاض كبير فى ضغط الدم الانقباضى والانبساطى ومعدل ضربات القلب أثناء الراحة بالإضافة إلى الكوليسترول الكلى، والمنخفض الكثافة ومستويات السكر الصائم فى الدم والهيموجلوبين السكرى.

ومع ذلك، لم يكن هناك انخفاض معتد به إحصائياً فى الدهون الثلاثية، مؤشر كتلة الجسم، والوزن. بالإضافة إلى ذلك، لوحظ تحسن كبير فى القدرة الوظيف، ونوعية الحياة المتعلقة بالصحة. لم يلاحظ أى أحداث قلبية سلبية كبيرة حتى الانتهاء من البرنامج.

الخلاصة : أظهر مرضى ما بعد الاحتشاء الذين تمت إحالتهم إلى برنامج إعادة تأهيل القلب الشامل القائم على التمرين لمدة ١٢ أسبوعاً تحسناً فى القدرة على ممارسة الرياضة، وضغط الدم، ومعدل ضربات القلب أثناء الراحة. وإجمالى الكوليسترول والكولسترول منخفض الكثافة والاحداث السلبية الكبرى، والأداء النفسى والاجتماعى واستانف ٩٣.٣٪ ALM أعمالهم التى كانوا يزاولونها قبل الاحتشاء.