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Cardiac rehabilitation improves the ischemic burden in patients with ischemic heart disease who are not suitable for revascularization

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ABSTRACT

Background: Ischemic heart diseases including stable angina & acute events, represent a huge burden on both the individual & the society and represent an important source of disability.
Aim: We aimed to identify the effect of cardiac rehabilitation program (CRP) on the ischemic burden in patients with ischemic heart disease (IHD) unsuitable for coronary revascularization.
Methods: The study included 40 patients with IHD who were not suitable for coronary revascularization either by PCI or CABG (due to unsuitable coronary anatomy, co morbidities, high surgical/procedural risk or patient preference). All patients were subjected to sophisticated CRP protocols, including patient education, nutritional, medical, psychological and sexual counseling and group smoking cessation. All patients participated in low intensity exercise program twice weekly. The patient's symptoms, vitals and medications were evaluated at each visit and clinical and laboratory data, echocardiography and stress myocardial perfusion imaging (SPECT) were evaluated before and 3 months after the end of the study.
Results: The mean age was 56.8 ± 3.1 years and only 2 patients (5%) were females. 22 (55%) patients were diabetic, 21 (53%) were hypertensive and 30 (75%) were smokers. It was found that 3 months after completion of CRP, there was a significant decrease in BMI (30.3 ± 2.9 vs. 31.2 ± 1.9, $p < 0.001$), and mean blood pressure (93.4 ± 11 vs. 105 ± 10.6 mmHg, $p < 0.001$). There was also a favorable effect on lipid profile and a significant improvement of the functional capacity in terms of NYHA functional class (2.1 ± 0.62 vs. 1.4 ± 0.6, $p < 0.001$). Despite that wall motion score index did not significantly change after CRP, there was a strong trend toward a better ejection fraction (53.7 ± 7.8 vs. 54.5 ± 6.3 %, $p = 0.06$) and significant improvement of Canadian cardiovascular class (1.42 ± 0.6 vs. 1.95 ± 0.5, $p < 0.001$) post CRP. Importantly, the difference between the SPECT-derived summed segmental scores at peak stress and at rest (SDS) was significantly lower after CRP (4.4 ± 3 vs. 7.2 ± 3, $p < 0.001$).
Conclusion: Participation in cardiac rehabilitation program improves ischemic burden in patients with IHD who are unfit or not suitable for conventional cardiac revascularization. In addition the decreased ischemic burden, functional capacity, hemodynamic and metabolic profiles also improve for this group of patients and thus, cardiac rehabilitation should be implemented for routine management of those patients.

1. Introduction

Coronary heart disease (CHD) is an important source of disability; heart failure and residual angina symptoms disable the patient to carry out his work and role in the society. Cardiac rehabilitation is an essential component of the contemporary management of patients with CHD.

The objective of cardiac rehabilitation is to improve both the physiologic and psychosocial status of cardiac patients. The physiologic outcomes include improvement in exercise capacity and optimization of risk-factor status. Enhancement of myocardial perfusion and performance, as well as reduction in progression of the underlying atherosclerotic process, is additional goals [1]. In this study we aimed to identify the effect of cardiac rehabilitation on the ischemic burden in patients with ischemic heart disease who are not candidate for revascularization.

2. Methods

2.1. Identification and recruitment of patients

The study included 40 patients with stable IHD (post ACS or incomplete revascularization) who are not suitable for revascularization either by PCI or CABG (due to unsuitable coronary anatomy, co morbidities, high surgical/procedural risk or patient preference). The patients were enrolled in cardiac rehabilitation unit in Ain Shams University Hospital.

Abbreviations: CRP, Cardiac rehabilitation program; SWMI, Segmental wall motion index; SDS, Summed difference score.

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Table 1
Basic demographic, clinical, echocardiographic and laboratory data:

Variable	N = 40
Age (years)	56.75 ± 3.11
Sex (male/female) n (%)	38 (95)/2 (5)
Risk factors: diabetes/hypertension/smoker n (%)	22 (55)/21 (52.5)/30 (75)
BMI (kg/m^2)	31.15 ± 1.91
NYHA: (I/II/III) n (%)	6 (15)/25 (62.5)/9 (22.5)
HR (beat/minute)	78 ± 18
SBP (mmHg)	142 ± 15.7
DBP (mmHg)	86.5 ± 9.21
ECG (sinus/AF) n (%)	40 (100)/0
EF (%)	53.70 ± 7.76
SWMI	1.28 ± 0.35
SDS	7.23 ± 2.97
LDL(mg/dl)	131.10 ± 31
HDL (mg/dl)	36.53 ± 6.94
HbA1c (%)	7.72 ± 1.29

We included only the patients who finished the 3 month course of cardiac rehabilitation in our unit attending >80% of the sessions.

Exclusion criteria:

- Ischemic patients who had complete revascularization.
- Patients with contraindications to exercise:
  - Active pericarditis or myocarditis.
  - Uncontrolled congestive heart failure.
  - Atrioventricular conduction defect (except first-degree atrioventricular block).
  - History of sustained ventricular arrhythmia, uncontrolled atrial fibrillation.
  - Severe pulmonary hypertension.
  - End stage hepatic and/or renal failure.
  - Symptomatic valvular heart disease.
  - Fixed-rate pacemaker.
  - Intermittent claudication.
  - Anemia (hemoglobin <9 g/dl).
  - Significant electrolyte abnormality.

2.2. Procedure

2.2.1. Proper history taking and examination

All patients were subjected to thorough history taking, full clinical examination including general and local cardiac examination and 12 lead E.C.G were done.

2.2.2. Biochemistry

Venous blood sample were drawn from the antecubital vein before and after rehabilitation program, HbA1c and lipid panel were measured using standard laboratory methods.

2.2.3. Echocardiographic study

All echocardiographic studies were performed before and after rehabilitation program, with commercially available echocardiography systems equipped with a 2.5-MHz multi frequency phased array transducer (Vivid 5 or Vivid 7, GE-Vingmed, Morton, Norway). Gain settings, sector width and the frame rate were adjusted for routine grayscale 2D imaging to optimize endocardial definitions. Standard apical and parasternal views at depths of 12–20 cm were obtained at end-expiratory apnea. LV end-diastolic volume, end-systolic volume (ESV), and ejection fraction were obtained using the modified biplane Simpson's method from the apical 2- and 4-chamber images. All measurements were made in >3 consecutive cardiac cycle and in >5 cycles if the patient's rhythm was atrial fibrillation (AF) and average values were used for the final analyses. SWMI was obtained by dividing the left ventricle into 17 segments. Each of the segments was assigned a score that is based on myocardial thickening. A normally contracting segment was assigned a score of 1; hypokinesia, 2; akinesia, 3; dyskinesia, 4; and aneurismal, 5. Wall motion score index was calculated by dividing the sum of scores by the number of segments visualized [2].

Table 2
Smoking status before & after CRP.

Smoking	Before		After		Chi-square test	
	No.	%	No.	%	X^2	P-value
Negative	10	25.00%	31	77.50%	22.064	0.001
Positive	30	75.00%	9	22.50%		
Total	40	100.00%	40	100.00%		

Table 3
Impact of cardiac rehabilitation on cardiovascular risk factors.

	Before		After		Paired t-test	
	Mean	SD	Mean	SD	t	p-value
BMI (kg/m^2)	31.15	1.91	30.28	2.19	6.328	0.001
Waist circumference (cm)	110.60	6.04	107.0	6.16	8.628	0.001
SBP (mmHg)	142.00	15.76	126.37	15.69	9.041	0.001
DBP (mmHg)	86.50	9.21	77.13	9.33	8.062	0.001
LDL (mg/dl)	132.10	31.00	104.03	20.67	12.776	0.001
HDL (mg/dl)	36.53	6.94	42.20	6.84	36.962	<0.001
HbA1c (%)	7.27	1.29	6.77	0.83	5.307	0.001

2.2.4. Stress test with myocardial perfusion scan (SPECT)

All patients included in the study underwent myocardial perfusion imaging before and after rehabilitation program by means of physical treadmill stress Tc99 sestamibi SPECT.

Data acquisition ECG-gated SPECT imaging was performed using a 2-day protocol (stress and rest) with 99mTc sestamibi (99mTcMIBI). All patients underwent physical treadmill exercise test with Bruce protocol and 99mTcMIBI (500 MBq) was injected intravenously at peak stress. Imaging was performed 120 min after radio-pharmaceutical injection using a dual-head SPECT gamma camera using low-energy, high-resolution collimators. Images were acquired using a circular 360° orbit, 60 projections and 40 s per projection [3].

The myocardium was divided into 17 segments and each segment was evaluated in consensus by two expert observers using a four-point scoring system (0 >75% tracer uptake, 1: 50–75% tracer uptake, 2: 25–50% tracer uptake and 3: <25% tracer uptake) [4]. The summed stress score (SSS) and summed rest score (SRS) were obtained by summation of the individual segmental scores in stress and rest, respectively. The summed difference score (SDS) was calculated by subtracting the SRS from the SSS, which represents both the extent and severity of perfusion abnormalities. Using the gated images, regional wall motion was analyzed to improve differentiation between true perfusion abnormalities and attenuation artifacts. Images were evaluated for the presence of perfusion abnormalities as well as other non-perfusion abnormalities that may indicate extensive ischemia, including left ventricular dysfunction (defined as a left ventricular ejection fraction <45%) and transient ischemic dilation [5]. The segmental scores were assigned subjectively by the image interpreter and/or automatically by JEP Philips program (JET Stream workspace version 3 servicepack #3 jsws-gnm 320R01).

Table 4
Effect cardiac rehabilitation on functional capacity.

NYHA	Before		After		Chi-square test	
	No.	%	No.	%	X^2	P-value
1	6	15.00%	27	67.50%	23.263	0.001
2	25	62.50%	11	27.50%		
3	9	22.50%	2	5.00%		
Total	40	100.00%	40	100.00%		