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Benefits of Cardiac Rehabilitation on Lipid Profile in Patients with Coronary Artery Disease

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Abstract: This cross-sectional study was performed in patients following coronary interventions, to evaluate the effect of cardiac rehabilitation on functional capacity, maximum heart rate on exercise and serum lipid profiles. Consecutive patients after coronary artery intervention randomly referred to cardiac rehabilitation. All patients underwent based exercise tolerance test to define exercise capacity. Blood samples were obtained to measure based plasma lipid profiles and nutritional counseling provided to all participants. Also, psychological evaluation was performed with the some documented questionnaire to explore emotional, behavioral and psychological state. After completion of cardiac rehabilitation in all patients, reassessment of work capacity, plasma lipid profile and psychological state were performed. After cardiac rehabilitation for 8-12 weeks, functional capacity improved in 83% of patients ($p<0.001$) and maximal heart rate at the same time on exercise decreased in 72%. The average time on treadmill was 7.76 min before and 9.56 min after cardiac recreation ($p<0.001$). After cardiac rehabilitation, plasma total cholesterol, low-density lipoprotein and triglyceride significantly decreased. At the end, 97% of patients returned to work and had sense of well-being. Cardiac rehabilitation has important impacts on improving functional capacity, well being sensation, return to work and decreasing serum lipid profiles in coronary patients.

Key words: Cardiac rehabilitation, exercise tolerance test, functional capacity

INTRODUCTION

Cardiac Rehabilitation (CR) is a multidisciplinary rehabilitation program established to assist individuals with heart disease in achieving optimal physical, psychological and social status within limits of their disease (Karapolat and Durmaz, 2008). Comprehensive CR programs that address risk factors, psychological problems and physical activity are essential in optimizing health and reducing the risk of further cardiac events (Oliveira *et al*., 2008; Wachtel *et al*., 2008). The goal of CR programs is not only to prolong life, but also to improve physical functioning, symptoms, wellbeing and health-related quality of life (Höfer *et al*., 2006). Indeed, many reports have shown the benefits of cardiac rehabilitation program (Karapolat and Durmaz, 2008; Oliveira *et al*., 2008; Wachtel *et al*., 2008; Piotrowicz and Wolszakiewicz, 2008; Hansen *et al*., 2008; Gałaszek *et al*., 2006; Dendale *et al*., 2008), but the effectiveness of these programs in reducing morbidity and mortality is largely unknown.

This study was performed in post CABG (coronary artery bypass grafting) or post PCI (percutaneous transluminal coronary angioplasty) patients. The aim of this prospective study was to investigate influences of supervised comprehensive cardiac rehabilitation on exercise capacity, psychological factors and plasma lipid profiles in patients with coronary artery disease.

MATERIALS AND METHODS

Patients survived after first acute myocardial infarction (AMI), CABG, PCI and valvular heart operation referred to cardiac rehabilitation center randomly by different cardiologists or cardiac surgeons. Inclusion criteria were history of CABG, PCI or valvular heart operation, history of recent (4-6 weeks ago) first acute myocardial infarction and sinus rhythm. Exclusion criteria were conduction abnormality, contraindications to perform exercise and physical and medical instability. From September 2000 through July 2001, 76 patients were referred to CR programs. All patients provided signed

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informed consent before investigation. After completion of medical history and physical examination, all patients underwent a complete echocardiography study as the initial evaluation to assess left ventricular function. Also in all patients, based electrocardiography (ECG) monitored treadmill multistage graded exercise tests (ETT) were performed. A test was terminated when he/she request for it for any reason or evidence of ischemia, developed abnormality such as ST depression in ECG, declined blood pressure or reported symptoms including chest pain or shortness of breath or fatigue.

The stage and metabolic equivalents (METs) level at the end of the ETT were considered as a patient's maximal physical capacity (Karapolat and Durmaz, 2008; Piotrowicz and Wolszakiewicz, 2008). After exclusion of eleven patients due to early positive for ischemia on exercise tolerance test, low exercise capacities (METs <7) and lack of regular cooperation to take part in CR Programs, 65 patients were enrolled for this study. In all patients blood samples were obtained to measure based plasma lipid profiles such as Total Cholesterol (TC), Low Density Lipoprotein (LDL), High Density Lipoprotein (HDL) and triglyceride (TG). At the same time, nutritional counseling provided to all participants to achieve restriction in saturated fat and cholesterol and maintain normal body weight. Then, all patients underwent health education counseling, psychotherapy, stress management training programs, smoking cessation and maintenance of cessation and relaxation training by psychologists.

For all patients, an exercise program was developed on the basis of each patient's ETT results. An exercise target heart rate was defined as 80% of the maximal heart rate on its ETT. All patients continued their routine medications during trial, except they did not take their diuretic doses in the morning of exercise. The patients were supervised by continuous ECG monitoring to exercise in 3 phases (Karapolat and Durmaz, 2008; Piotrowicz and Wolszakiewicz, 2008).

- **Phase I:** Warm up (light flexibility): 5-10 min
- **Phase II:** Aerobic training activity: (on bicycle or treadmill): 30-40 min
- **Phase III:** Cool-down (slow walking and stretching): 5-10 min

Blood pressures measurements were performed every 5 min in phase 1 and the end of other phases. During each supervised session, intensity of exercise and heart rate from ECG monitoring were recorded. All patients continued the exercise program three times a week for 8-12 weeks. Exercise was stopped if patients experienced any cardiac signs or symptoms or ECG abnormalities. After 8-12 weeks, a participant exercised at an intensity level to reach its individually target heart rate and duration of exercise. After termination of CR Programs for final evaluation, all patients underwent echocardiography study, plasma lipid profile measurement and psychological assessment (Karapolat and Durmaz, 2008; Piotrowicz and Wolszakiewicz, 2008).

Statistical analysis: All data of the patients were compared using the paired Student t-test for continuous variables and the χ^2 test for discrete variables. Differences were considered significant at a value of $p<0.05$.

RESULTS

A total of 76 patients referred to CR program, eleven patients excluded from CR program due to lack of regular coordination in program, early positive for ischemia in base Exercise Tolerance Test (ETT) and atrial fibrillation rhythm.

Sixty-five patients (50 men and 15 women; mean age 55±8.5 years) were enrolled in the study and completed it. Demographic data for the 65 patients are shown in Table 1. All patients had coronary artery disease and majorities of them (92%) had history of intervention for coronary arteries.

Exercise performance: Maximal heart rate (MHR) after CR at the same time on ETT, in 72% of patients decreased and the rest were unchanged or increased. Also mean time of exercise tolerance test increased from 7.77 min before to 9.56 min after CR Programs ($p<0.001$) (Fig. 1).

Figure 2 and 3 show comparison of exercise result and lipid profile values before and after CR Programs. In comparison of the initial with the final programs, total work capacity (METs) in 83% of patient's increased from 8.7 to 10.8 ($p<0.001$) (Fig. 2).

Improvement of work capacity was similar in both sex groups. Cardiac rehabilitation programs and exercise

Table 1: Demographic data of enrolled patients (65 Patients)

Age (year)	35-71 (55)	
Male/Female	50/15	
Post CABG	53 (81%)	(86% 3VD) (14% 2VD)
Post PTCA	7 (11%)	
Post MI	2 (3%)	
Chronic stable angina	3 (5%)	
Hyperlipidemia	37 (57%)	
Hypertension	29 (45%)	
Smoking	24 (37%)	
Diabetes mellitus	19 (29%)	
Left ventricular ejection fraction	41±4%	

CABG: Coronary artery bypass grafting; PTCA: Percutaneous transluminal coronary angioplasty

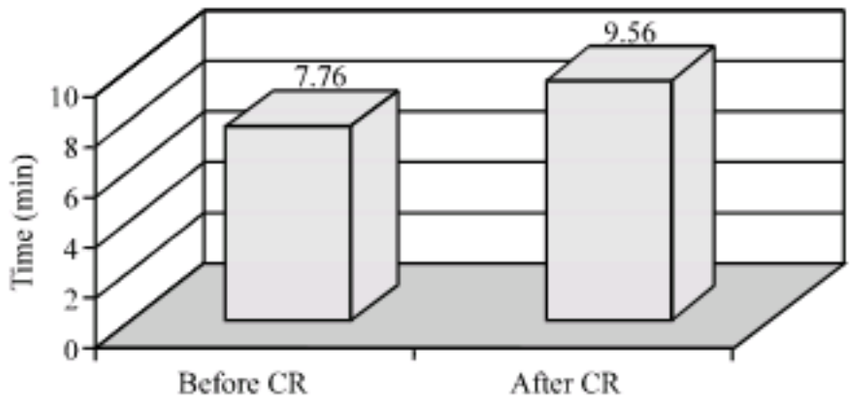

Fig. 1: Duration of exercise tolerance test before and after cardiac rahabilitation program

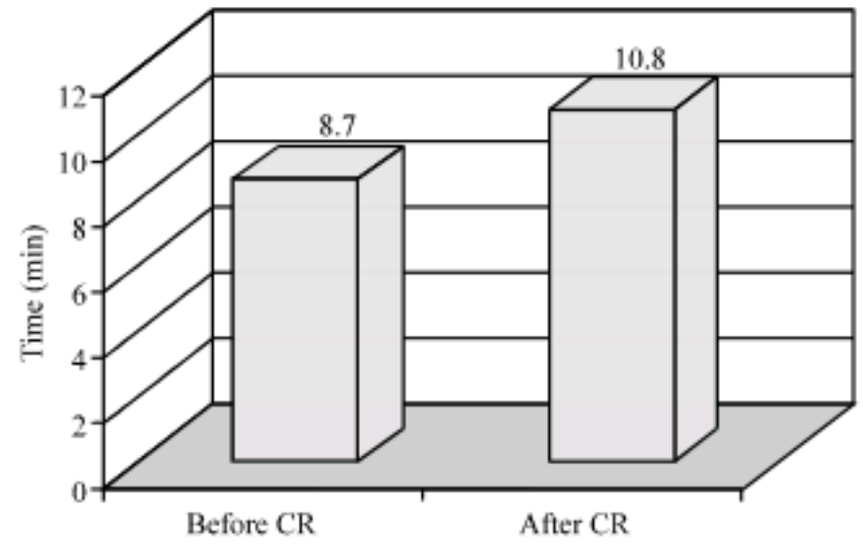

Fig. 2: Mean exercise capacity on ETT before and after cardiac rahabilitation program

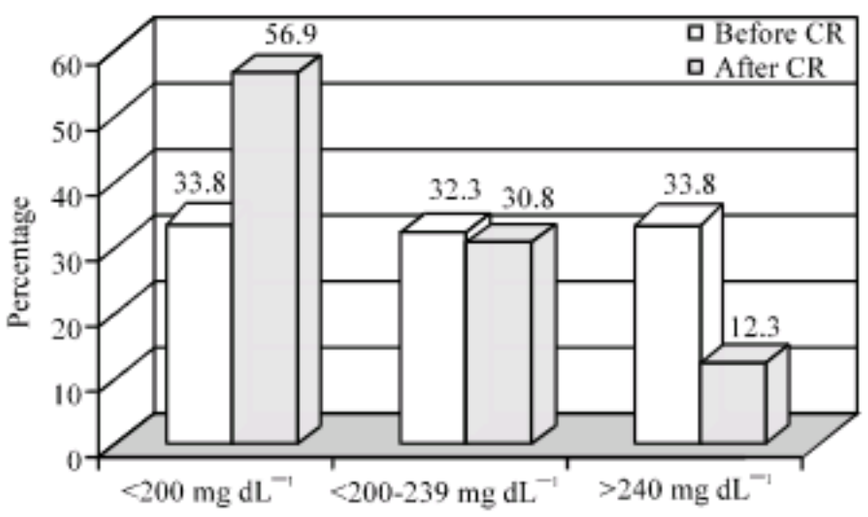

Fig. 3: Amount of total cholesterol before and after cardiac rehabilitation program

training result in significant improvement in plasma lipid profiles. Total cholesterol and Low-density lipoprotein in 75% and Triglyceride in 95% of patients significantly reduced during the program; although 43% of patients received lipid lowering drugs (Fig. 3).

In assessment of psychological condition, 12% of patients had moderate to severe depression before CR. Anxiety disorders are manifested in approximately 5-10% of patients. After CR programs, 91% of patients had decrease in life stress and depressed mood and significantly improvement in general well being ($p<0.01$). At the end, 97% of patients returned to work and had sense of well-being.

Average left ventricular ejection fraction (LVEF) was 41±4% before CR and in 72% of patients LVEF slightly increased.

DISCUSSION

Low level of physical activity seen in the general population regardless of the age group is alarming. Many patients commencing cardiac rehabilitation have never exercised regularly before, have no habit or need to engage in any physical activity and easily become disheartened with training. Even healthcare professionals neglect the importance of physical activity in primary and secondary prevention (Piotrowicz and Wolszakiewicz, 2008). Evidence shows that exercise-based Cardiac rehabilitation (CR) after cardiac events positively affects the extent of disability and level of quality of life and has also important beneficial role in modifying morbidity and mortality. CR is an integral component of the care for patients who have undergone acute myocardial infarction, after invasive coronary procedures and those with chronic stable angina (Piotrowicz and Wolszakiewicz, 2008; O'Driscoll *et al*., 2007; Jiang *et al*., 2007). In present study, after CR programs, 91% of patients had decrease in life stress and depressed mood and significantly improvement in general well being. So that 97% of patients returned to work and had sense of well-being. According to the 1964 World Health Organization definition, CR includes all actions undertaken to provide optimal physical, mental and social environment for the cardiac patient to let him or her regain maximal functional capacity in the society (Piotrowicz and Wolszakiewicz, 2008; Gałaszek *et al*., 2006; Williams *et al*., 2006). Thus, CR should be multifaceted and comprehensive, including: clinical evaluation, optimization of pharmacotherapy, physical training, psychological rehabilitation, evaluation and reduction of coronary disease risk factors, life style modification and patient and family education. Modern model of comprehensive CR should be initiated as early as possible and individualized depending on clinical status of the patients (Piotrowicz and Wolszakiewicz, 2008; Gałaszek *et al*., 2006; Williams *et al*., 2006). CR has gained widespread acceptance as an integral component in the management of patients with several forms of cardiac disease (Vigorito *et al*., 2003; Fattirolli *et al*., 2005). However, to date we did not find a prospective, randomized clinical trial in our region, evaluating influences of supervised comprehensive cardiac rehabilitation on exercise capacity, psychological factors and plasma lipid profiles in patients with coronary artery

disease. Until 1960s, bed rest or major limitation of exercise were considered beneficial for the majority of patients. In contrast, moderate or even intense exercise training is currently used not only in the prevention of coronary heart disease, but also as a therapeutic measure following myocardial infarction, percutaneous Coronary Intervention (PCI), cardiac surgery and permanent pacemaker or cardioverter-defibrillator implantations. For some years now, physical rehabilitation is also undertaken in patients with heart failure regardless of its etiology (Piotrowicz and Wolszakiewicz, 2008; Gałaszek *et al*., 2006).

Meta-analyses demonstrate that patients randomized to exercise-based CR after MI have a statistically significant reduction in all-cause and cardiac mortality of about 20 to 25% compared to patients receiving conventional care (Jolliffe *et al*., 2001).

Comprehensive CR in patients with AMI treated with percutaneous coronary intervention (PCI) of the infarction related artery improves recovery at 6-month follow-up. It has a favorable impact on the anginal and heart failure sym ptoms, cardiac risk factors (especially physical activity, restrictive diet), psychological and physical status. It contributes towards maintaining a further event-free period. It improves selected cardiovascular parameters such as exercise tolerance, segmental and global left ventricular function (Dendale *et al*., 2008; Piestrzeniewicz *et al*., 2004). CR has been shown to reduce short-term mortality and morbidity after Percutaneous Coronary Intervention (PCI). Dendale *et al*. (2008) showed that CR after PCI not only significantly reduces the number of cardiac events, but, despite the additional cost due to CR, results in cost savings from the Belgian health care payer's perspective.

Rehabilitation and secondary prevention in patients with cardiovascular disease impact positively on their mortality, morbidity, economy and quality of life. In addition, they are a coadjuvant to the medical programs to treatment even in high risk patients (Wenger, 2008; Ilarraza Lomelí, 2007). After an uncomplicated revascularization procedure, physical training plus information results in a comparable outcome on quality of life when compared to a more comprehensive program including additional psycho-education and relaxation therapy (Brügemann *et al*., 2007). Exercise training is currently recommended for patients after myocardial infarction (NE), CABG, PCI and other cardiac conditions (Fletcher *et al*., 1996). Although, exercise training for coronary artery disease patients is called CR, exercise is only one component of comprehensive CR Programs. Many reports have shown the benefits of CR including lower morbidity and mortality after even in depressed LV function compared with patients no participating in CR-programs (Hambrecht *et al*., 1995). The beneficial effects of CR program have been shown to improve optimal physical working capacity even in patients with depressed ventricular function and particularly in those with decrease functional capacity (Belardinelli *et al*., 1995). Observations suggest that patients with normal flow responses would likely respond to CR, whereas patients with reduced flow responses would not benefit from an exercise program (Wilson *et al*., 1996). These studies extend exercise training in patients with depressed LV function. In the present study, the average left ventricular ejection fraction (LVEF) increased in 72% of patients.

At present, revascularization procedures greatly reduce the symptoms of myocardial ischemia and may also reduce the subsequent incidence of morbid and fatal events. If we can succeed in helping patients to stop smoking, control weight, exercise regularly and take all medications prescribed, the burden of illness from cardiovascular diseases will fall even more dramatically (Alan-Herd, 2000).

Our findings confirm that supervised exercise training programs is effective in improving exercise tolerance time and working capacity without cardiovascular complications or other adverse outcome. Similar to more reports (Fletcher *et al*., 1994), in our study exercise performance and working capacity significantly increased after 8-12 weeks of CR programs. Most patients in our study after a CR program found reduced maximal heart rate (MHR) at the same time compared with before starting exercise training. These findings compatible with other studies regarding to reduction in exercise heart rate and rate-pressure product (Hull *et al*., 1994; Mirat, 2007).

Physical activity has a beneficial impact on the cardiovascular system, both directly by improving endothelial function and indirectly by normalizing risk factors of atherosclerosis, such as dyslipidemia, high blood pressure, obesity and by positive effects on coagulation mechanism. The impact of physical activity on the cardiovascular system is manifested by immediate changes in hemodynamics, blood pressure and heart rate during physical training (Mirat, 2007). Other findings showed beneficial changes in autonomic balance and attenuation of the vasoconstrictor influences (mainly due to sympathetic activity) and the increased vagal tone after training in animals (Hull *et al*., 1994).

Prospective epidemiological studies have shown that sedentary life style has a twice-higher risk of sudden death and cardiovascular mortality. Evidence based data show a 20-25% lower mortality rate after myocardial infarction in the patients submitted to rehabilitation program of physical exercises (Mirat, 2007; Taylor *et al*.,

2006). Physical activity in patients with coronary artery disease must be individualized, quantified and under control. In subjects with impaired function of the heart muscle, physical activity is limited with characteristic symptoms-dyspnea and stenocardia. It has been shown that physical training in controlled quantities decrease relative risk of mortality by 35% and hospitalization by 28% in chronic heart failure. Physical training is beneficial for all forms of heart failure in terms of decreased mortality and improvements of the muscle mass and physical status (Mirat, 2007; Grace *et al*., 2008). As the more mentioned reports, in the present study total cholesterol, low density lipoprotein and triglyceride significantly reduced during the 8-12 weeks of programs. All patients in our study have nutritional counseling regularly and 43% of them received lipid lowering drugs. A diet restricted in saturated fat and cholesterol and designed to achieve and maintain normal body weight is an important component of a lipid-management program. Although some studies show only small reductions in LDL cholesterol, LDL heterogeneity may improve with exercise training, which is less atherogenic (Lavie and Milani, 1994). In our series, total cholesterol and LDL cholesterol was reduced significantly in 75% and triglyceride decreased significantly in 95% during the CR program.

Approximately half of the 28% reduction in cardiac mortality achieved with exercise-based CR may be attributed to reductions in major risk factors, particularly smoking (Taylor *et al*., 2006). Smoking in patients with CAD is associated with increased mortality and morbidity (CDC, 2008). All patients in our study quit smoking during CR programs.

Psychosocial problems are common in patients enrolled in outpatient CR programs. In one study, moderate to severe depression occurred in 10-20% of patients after an acute MI (Shuster *et al*., 1992). Symptoms of depression and anxiety affected change in exercise capacity during CR. Depressive symptoms may impair improvement in exercise capacity, thereby mitigating the cardiovascular benefit achieved by CR programs (Egger *et al*., 2008). In our study that most patients were post CABG, only 12% of cases had moderate to severe depression. Anxiety disorders are manifest in approximately 5-10% of patients. Depression following major cardiac events is associated with higher mortality, but little is known about whether this can be reduced through treatment including CR and exercise training (Milani and Lavie, 2007). In patients following major coronary events, CR is associated with both reductions in depressive symptoms and the excess mortality associated with it. Moreover, only mild improvements in levels of fitness appear to be needed to produce these benefits on depressive symptoms and its associated mortality (Milani and Lavie, 2007). In this study, evaluation of well-being sensation after CR programs showed that up to 91% of patients satisfied from decreasing depression, anxiety and anger and improving quality of life and 97% achieved the sense of well-being. This results were better than other reports, although they showed marked benefit following CR programs in the coronary patients with psychosocial problem (Milani *et al*., 1996; Milani and Lavie, 1998; Lavie *et al*., 1999; Lavie and Milani, 1999).

Present study limitations were absence of control group, short period of follow-up, need to evaluate on large group of patients and comparative study between patients and controls.

CONCLUSION

Cardiac rehabilitation (CR) can be important as a useful adjunct therapy to CABG, PTCA or existing medical therapy in helping people to return to normal activities. Present data indicate that CR program is feasible and effective in improving working capacity, exercise time and quality of life in patients after CABG or PTCA. The results of this study highlight the need for increased investment, improved planning and the introduction of a comprehensive training program for healthcare practitioners in CR. Implementation of these actions may reduce many of the service limitations and barriers that currently surround CR programs. It is advisable to cardiologists that in their medical practice, advise to their low risk patients, on physical activity as a secondary prevention measure.

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