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Effects of hospital-based cardiac rehabilitation and home-based exercise program in patients with previous myocardial infarction

Miyokard infarktüsü geçirmiş hastalarda hastanede kardiyak rehabilitasyon ve ev egzersiz programının etkileri

Nuray Saygin Aydin[1], Sevil Ceyhan Doğan[2], Hasan Yucel[3], Ali Zorlu[4], Mehmet Birhan Yilmaz[5]

[1] Department of Physical Medicine and Rehabilitation, Sanliurfa Education and Research Hospital, Sanliurfa, Turkey
[2] Department of Physical Medicine and Rehabilitation, Cumhuriyet University Faculty of Medicine, Sivas, Turkey
[3] Cardiology Clinic, Big Anatolia Private Hospital, Samsun, Turkey
[4] Cardiology Clinic, Mujde Private Hospital, Malatya,Turkey
[5] Department of Cardiology, Cumhuriyet University Faculty of Medicine, 58140 Sivas, Turkey
Corresponding author: Sevil Ceyhan Doğan, Department of Physical Medicine and Rehabilitation, Cumhuriyet University Faculty of Medicine, Sivas, Turkey
E-mail: drsevilceyhan@gmail.com
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SUMMARY

Background: Exercise-based rehabilitation is an important part of treatment patients following myocardial infarction.
Objective: The aim of our study was to compare the effects of exercise therapy on cardiopulmonary parameters by prescribing hospital-based cardiac rehabilitation, home-based exercise program in patients with previous myocardial infarction.
Method: We studied 35 post–myocardial infarction patients having a 1-month myocardial infarction history with a stable disease. The patients were randomly assigned to 2 groups as follows: aerobic exercise training group (I), home-based exercise group (II). The group I participated in the aerobic exercise program at the hospital for 6 weeks. Group II was prescribed a home-based gradual physical activity program.
Results: It was found that there were significant increases in the values of ejection fraction (EF), the six-minutes-walk test (6-MWT), arm ergometer test, VO2max, anaerobic time in group I. It was also found that there were significant increases in the values of 6-MWT, arm ergometer test, and anaerobic time in group II. The ratio of change in arm ergometer test values was higher in the hospital group.
Conclusions: Home-based exercise programs can be a good alternative for patients with low or moderate risk who can't attend hospital-based exercise programs.
Keywords: Cardiac rehabilitation, myocardial infarction, home-based exercise program, hospital-based exercise program

ÖZET

Amaç: Miyokard infarktüsü (MI) geçiren hastalarda, egzersiz temelli rehabilitasyon, tedavinin önemli bir parçasıdır. Çalışmamızın amacı, MI geçiren hastalarda, hastanede yapılan kardiyak rehabilitasyon ile ev egzersiz programının kardiyak parametreler üzerindeki etkisini karşılaştırmaktı.

Yöntem: Çalışmaya 1 ay öncesinde MI geçiren stabil 35 hasta alındı. Hastalar rastgele iki gruba randomize edildi: aerobik egzersiz eğitimi grubu (I), ev egzersiz grubu (II). Grup I, hastanede 6 haftalık aerobik egzersiz programına katıldı. Grup II için evde aşamalı fiziksel aktivite programı öngörüldü.

Bulgular: Grup I'de, ejeksiyon fraksiyonu (EF), altı dakika yürüme testi (6-DYT), kol ergometresi testi, VO2max ve anaerobik zaman (AT) değerlerinde artış olduğu bulundu. Aynı zamanda grup II'deki 6-DYT, kol ergometresi testi ve

AT değerlerinde de anlamlı artışlar vardı. Kol ergometresi testi değerlerindeki değişim oranı, hastane grubunda daha yüksekti.

Sonuçlar: Hastanede yapılan egzersiz programına katılamayacak düşük veya orta riskli hastalar için, evde yapılan egzersiz programları, iyi bir alternatif olabilir.

Anahtar kelimeler: Kardiyak rehabilitasyon, miyokard infarktüsü, ev egzersiz programı, hastanede egzersiz programı

INTRODUCTION

Myocardial infarction (MI) is the leading cause of morbidity and mortality in the world. Although the survival in patients with MI has increased during the last 20 years, the quality of life has declined markedly. Moreover, as atherosclerosis is a chronic process, patients are prone to developing MI again and have a sudden death risk with possible cardiac symptoms [1].

Today, cardiac rehabilitation (CR) and secondary prevention programs have become indispensable parts of medical treatment in cardiovascular patients. CR, which is an approach where multiple disciplines are applied in a coordinated treatment program, is defined as a comprehensive and long-term program aiming at maintaining the quality of life at a maximum level in terms of physical, physiological, social and occupational performances through personalized and physician-controlled exercise, medical evaluations, risk profiles, training consultancy, and modification of coronary risk factors using drug and non-drug treatment approaches[2].

Rehabilitation of MI patients covers the activities required for optimizing the physical, mental and social conditions to help patients regain an active and productive life. CR program aims at decreasing the risk factors causing and accelerating the disease, modifying the lifestyle, revealing the positive effects of exercise on cardiovascular system, limiting the effects of physiological and psychological adverse effects of the disease, decreasing the risk of sudden death and re-occurrence of cardiac infarction, controlling cardiac symptoms, stopping the atherosclerotic process and improving the psychosocial and occupational statuses of the patients [3, 4, 5].

The enrollment rates for those entering CR programs are 10-20% percent annually in the United States of America [6]. In a study conducted by Çiftçi et al. in our country, it was emphasized that CR programs were not sufficiently employed in cardiology [7]. The aim of the present study was to study the effects of exercise therapy on clinical parameters by prescribing hospital-based CR and home-based exercise program in patients with previous MI.

MATERIAL AND METHODS

Study Design

This study was planned as a randomized cotrolled, prospective study at the Department of Physical Medicine and Rehabilitation and Cardiology at Cumhuriyet University, Turkey and was carried out between March 2014 and August 2014. The number of the patients and controls were assigned by statistical methods (using PASS 2008 Home-Power Analysis and Sample Size Program) where α=0.05, and the power of the test was found to be P=0,80270.

The Human Ethics Committee of Cumhuriyet University approval was obtained (Decision no: 2012-09/14; Date: 25.09.2012) and the study was conducted in accordance with the Helsinki Declaration. All study participants provided informed a written consent.

Case selection

It was planned to include in the study 40 patients followed up for MI in the previous one month. Fifty patients having a month MI history with a stable disease at the Department of Cardiology, Cumhuriyet University Hospital were interviewed. Ten patients were excluded from the study due to heart failure (n=4), uncontrolled hypertension (n=2), unstabile angina (n=1), pericarditis (n=1), orthopedic disorder (n=2). Those interviewed were told the benefits of CR and advised to attend either at hospital-based or home-based exercise programs. Those accepting to attend the program were randomly included in the study and there was no age limitation and regardless of gender. The method of randomization was odd–even number based and the patient group was divided into two groups, as the home-based exercise program group (n=20) and the hospital-based exercise program group (n=20). Five patients in home-based exercise programs dropped out after study beginning because they left the region.

The patients having unstable angina, uncontrolled arrhythmia, acute pericarditis, myocarditis, endocarditis, aortic dissection, history of Coronary Artery Bypass Grafting, a resting blood pressure higher than 200/120 mgHg, major psychiatric disorder, orthopedic disorder preventing exercise, and uncontrolled metabolic disease, those who discontinued treatment for various reasons and those not willing to participate in the study were excluded.

Evaluation

A detailed history was taken from each patient participating in the study, and cardiological and musculoskeletal examinations were carried out. At the beginning and on the 6th week of the study, all the patients were evaluated using the following methods and tests.

1. Lipid parameters and ejection fraction (EF) levels of the patients were measured before and after the exercise program.

2. Body mass index (BMI) were determined by the Quetelet's index (kg/m^2) [8]

3. Arterial blood pressure and electrocardiogram were followed in each phase of the modified Bruce protocol changing every 3 minutes. Heart rate was checked all through the exercise period. During the test, patients breathed through a face mask equipped with a gas meter measuring oxygen consumption and carbon dioxide production. The exercise test was ended when a patient was unable to continue the test for any reason or when indications requiring to stop the test were observed. During the test, the degree of fatigue was evaluated using the Borg Scale where ratings varied between 6 and 20. At the end of the test, the incline and rate at the last phase of the test, duration of the test, The Metabolic Equivalent of Task (MET) value achieved and heart rate were recorded.

4. Mechanical Arm Ergometer Endurance Tets: In order to evaluate the upper extremity exercise capacity of the patients, mechanical arm ergometer endurance test was performed. The duration along which the patients could exercise continuously at the mechanical arm ergometer equipment at 5 watts and 50 revolutions per minute (rpm) as recorded.

5. The six-minutes-walk test (6-MWT): The test was developed by Balke to evaluate functional capacity. [9,10]. The patients were asked to walk 30 m along the corridor at any walking speed and the distance they walked in 6 minutes was recorded [9].

Exercise Program

The patients included in the hospital exercise group attended an exercise program at the Physical Medicine and Rehabilitation Department, Cardiopulmonary Rehabilitation Unit under the supervision of an experienced nurse and a physical therapy technician. The exercise program, covering pulmonary and aerobic exercise, was designed aiming to increase the functional capacity of the patients. During the test, the patients were assigned to a treadmill and/or bicycle ergometry and upper extremity arm ergometer exercise program based on the VO2max and Anaerobic threshold (AT) values and in a manner that the targeted heart rate was reached.

The aerobic exercise started with a 5 minutes warm-up period, a 50 minutes main period and ended with 5-10 minutes cooling down. During warm-up period, the patients started exercising at a rate calculated based on the AT values determined during exercise test and reached the planned rate by the gradual increase in 5 minutes.

AT value was defined as the VO2 value at the time when the Respiratory Quotient (RQ), which is a ratio obtained by dividing VCO2 into VO2, was equal to 1. All the values were calculated by taking their averages in intervals of 20 seconds.

Moreover, maximum workload (watt) and exercise durations were recorded.

During cooling down, the rate of the exercise was decreased gradually in a 5 minutes period and the test was ended. No changes were made in the medical treatments of the patients and no diets were recommended.

The patients included in the home-based exercise group were individually trained on their diseases and the preventive measures were told. For a 6 weeks term, home-based gradual physical activity program was taught by a nurse.

Statistical Analysis

Parametric data were expressed as mean±standard deviation or median (interquartile range), and categorical data as percentages. SPSS 14.0 (SPSS, Inc., Chicago, Illinois) was used to perform the statistical procedures. Independent parameters were compared via independent sample's t test, and via Mann-Whitney U test with median and

25th-75th percentiles if there was no normal distribution. Categorical data were evaluated by chi-square test as appropriate. Temporal changes in parametric data were evaluated by the Wilcoxon signed rank test for paired samples. A p-value under 0.05 was accepted significant.

RESULTS

The baseline characteristics of the patients are summarized in Table 1. There was no difference between the groups in terms of age, gender, BMI, Hypertension, Diabetes Mellitus, smoking and cardiovascular drug use (p>0.05).

Table I: Comparison of baseline characteristics between hospital and home groups

	All patients (N = 20)	Hospital (N = 15)	Home	p
Age (years, X ± SD)	52±10	54±10	49±10	0.123
Gender (M/F) (%)	33/2 %94-%6	18/2 %90-%10	15/0 %100-%0	0.496
BMI (kg/m2, X ± SD)	29±5	30±42	8±5	0.065
HT (n, %)	17 (49%)	12 (60%)	5 (33%)	0.222
DM (n, %)	7 (20%)	6 (30%)	1 (7%)	0.199
Smoking (n, %)	24 (69%)	12 (60%)	12 (80%)	0.281
Drug use (n, %)				
Anti-platelet (n, %)	35 (100%)	20 (100%)	15 (100%)	1.000
Beta blocker (n, %)	29 (83%)	16 (80%)	13 (87%)	0.680
ACE inh / ARB (n, %)	17 (49%)	11 (55%)	6 (40%)	0.591
Statins (n, %)	33 (94%)	19 (95%)	14 (93%)	1.000

X: Mean, SD: Standard deviation, M: Male, F: Female, BMI: Body mass index, HT: Hypertansion, DM: Diabetes mellitus, ACE inh: Angiotensin-converting-enzyme inhibitor, ARB: Angiotensin receptor blocker

The pre-exercise and post-exercise clinical and laboratory findings of the patients are given in Table 2. When the pre-and post-operative blood lipid levels of those in Group 1 were compared, there was no statistically significant difference despite a decrease in the post-exercise lipid levels (p>0.05). When EF values of those in Group 1 were compared, post-exercise EF levels were found to be significantly higher when compared to the pre-exercise levels (49.55% ± 9.69 vs 51.75%± 8.58, p=0.004). In terms of 6-MWT (p=0.004), arm ergometer (p=0.001), V02max (p=0.001) and AT values (p=0.001), there was a significant improvement in Group 1.

Table II: Comparison of clinical and laboratory parameters obtained before and after exercise program

	Hospital (N = 20)		Home (N = 15)	
	Pre-exercise (Baseline)	Post-exercise (6 weeks)	Pre-exercise (Baseline)	Post-exercise (6 weeks)
Laboratory parameters				
HDL (mg/dL)	36.94 ± 5.32	36.98 ± 7.39	35.94 ± 7.31	35.89 ± 13.07
LDL (mg/dL)	92.47 ± 40.52	85.33 ± 35.90	89.34 ± 40.09	77.94 ± 31.97
C (mg/dL)	169.95 ± 44.54	149.70 ± 25.09	172.73 ± 48.25	144.60 ± 31.78
TG (mg/dl)	180.75 ± 95.73	167.80 ± 69.96	153.66 ± 77.96	188.33 ± 139.19
EF (%)	49.55 ± 9.69	51.75 ± 8.58*	50.66 ± 9.88	50.93 ± 7.59
Clinical parameters				
6MWT (m)	457.50 ± 81.87	516.00 ± 76.39*	458.66 ± 56.92	524.66 ± 84.58*
Arm ergometer (min)	4.59 ± 3.68	13.24 ± 9.08**	5.50 ± 3.77	8.05 ± 4.36*
VO2max (ml/kg/min)	19.34 ± 3.98	22.15 ± 4.19**	21.79 ± 3.43	24.28 ± 4.42
AT	4.13 ± 1.28	5.53 ± 1.32**	5.11 ± 1.12	6.21 ± 1.14*

HDL: High-density lipoprotein, LDL: Low-density lipoprotein, C: Cholesterol, TG: Triglyceride, EF: ejection fraction, 6MWT: 6 minutes walk test, VO2max: maximal oxygen consumption, AT: anaerobic threshold, *p < 0.05, *p < 0.01

No significant difference was found when pre and post-exercise blood lipid levels and EFs of those in Group II were compared (p>0.05). In terms of post-aerobic exercise 6-MWT (p=0.001), arm ergometer (p=0.001), V02max (p=0.001) and AT values (p=0.001), there was a significant improvement in Group 1 when compared to pre-aerobic exercise. Even though there was an improvement in VO2max levels, this was not statistically significant (p=0.063).

In Table 3, the difference between the changes in parameters of two groups is given. While there was no difference between the groups in terms of the changes in lipid parameters, EF, 6-MWT, V02max and AT ratios, arm ergometer test showed a significant increase in the hospital group when compared to the home group (p=0.004).

Table III: Comparison of percent change of parameters within groups

	All patients	Hospital	Home	p
Laboratory parameters				
HDL (%)	2.3 (10.1 / 0.3)	4.7 (13 / 5)	2.3 (11.2 / 1.3)	0.868
LDL(%)	-13 (-32 / 13)	- 7.9 (-22 / 22)	-13.9 (-35 / 5)	0.505
C (%)	-7.4 (-23 / 9)	- 5.7 (-21 / 10)	-10.8 (-25 / 0)	0.424
TG (%)	2.4 (-27 / 55)	- 0.8 (-30 / 25)	19 (-19 / 62)	0.217
EF (%) mean±SD (median)	4.2±11 (0)	5.2±7.4 (0)	2.8±14.7 (0)	0.156
Clinical parameters				
6-MWT (%)	12.5 (6 / 20)	12.7 (7.3 / 19)	8.7 (4.5 / 26)	0.987
Arm ergometer (%)	6.25 (3.3 / 19.3)	17.62 (5.7 / 36)	3.33 (1.42 / 10)	0.004
VO2max (%)	13.2 (3.5 / 20)	15.4 (7.6 / 20)	10.8 (-3.7 / 21)	0.463
AT (%)	25 (12.5 / 55)	31.6 (18.1-61.1)	19.6 (6.5 / 39.1)	0.083

HDL:High-density lipoprotein, LDL: Low-density lipoprotein, C: Cholesterol, TG: Triglyceride, EF: ejection fraction, 6-MWT: The six-minutes-walk test, VO2max: maximal oxygen consumption, AT: anaerobic threshold. All values are expressed as median (25-75 percentile).

DISCUSSION

In our study, EF values were increased in the individuals assigned to CR program while the said values did not change in the individuals assigned to the home-based exercise group. In patients assigned to hospital CR, 6-MWT and arm ergometer test values, VO2max and AT levels were found to be significantly increased after the treatment. In patients assigned to home-based exercise, 6-MWT and arm ergometer test values and AT levels were increased. When two groups were compared, only arm ergometer test values were significantly increased in patients assigned to hospital-based CR program while improvements in the other parameters were similar.

As a result of randomized studies on CR, significant results have been obtained on mortality. In a Cochrane systematic meta-analysis published in 2001, exercise-only CR program and comprehensive CR program were shown to decrease total cardiac mortality by 31% and 26%, respectively[11]. Moreover, comprehensive rehabilitation programs improve the quality of life[12].

Giannuzzi et al. studied the effects of an exercise training program on left ventricular function and remodeling after MI. The patients in the exercise group were subjected to 30 minutes bicycle ergometer at a rate that was 80% of the maximal heart rate at least 3 days a week for a 6 weeks term. At the end of the exercise period, a mild increase was observed in EF while there was a decrease in the ratio of abnormal wall motion and dilatation index [13]. Aros et al. assessed the effects of exercise training at home on functional parameters soon after MI and found a significant increase in cardiopulmonary parameters with a higher magnitude in the training group[14].

Kim et al. reported that the 6-months control echocardiography of the patients assigned to hospital CR had revealed a statistically significant improvement in EF levels. EF levels were increased in the home exercise group too but the difference was not statistically significant[15]. Similar results were obtained in two studies conducted later [16, 17]. In our study, consistent with

the literature, we found a significant improvement in the hospital group but no difference in the home exercise group. Similarly, Pavelo et al. found an increase in the 6-MWT and upper extremity muscle strength in the exercise group but the said increase was not statistically significant [17]. In a study on patients with stable chronic heart failure, Giannuzzi et al. randomized the patients to the exercise group and the control group. All the patients underwent echocardiography, 6-MWT and quality of life assessment at entry and at the end. During the controls performed after 6 months, there was a significant increase in all these parameters [18]. In our test, the ratio of increase in 6-MWT was similar in both groups.

In a systematic review and meta-analysis published in 2004, total cholesterol, triglyceride levels, and systolic blood pressure were reduced and there was a lower rate of smoking. However, there were no differences in High-Density Lipoprotein (HDL) and LDL levels and diastolic pressure [19]. In a study conducted by Lee et al., patients undergoing revascularization after acute MI were divided into two groups as the exercise group and the control group. Those in the control group were informed about the risk factors and the exercises they needed to perform. Among the blood lipid values of the exercise group, only HDL had a significant increase while there was no difference between the groups in terms of the other parameters [20]. In our study, the groups did not show any statistically significant difference in HDL, LDL, cholesterol and triglyceride values.

In a study conducted in 2011 on patients with coronary artery disease, Kim et al. divided the patients into two groups as the self-exercise group and the supervised exercise group. Controls were performed at baseline and 6 months and it was found that the groups were similar in terms of the improvement in the cardiopulmonary exercise capacity [21]. Dubach et al. randomized acute MI patients into a hospital group or control group. The hospital group underwent a 1-hour CR program daily for 8 weeks starting from the 35th day. The control group patients were not encouraged to exercise. In the exercise group, the increase in VO2max was statistically significant while there was no difference between the patients in the control group [22]. In a study evaluating the impacts of early CR program on myocardial function after acute MI, Kim et al. reported a significant increase in VO2max levels of the exercise group. In our study, the increase in VO2max level was statistically significant in the hospital group and insignificant in the home group.

Kargarfad et al. randomized patients undergoing MI into either the training group or the control group. The training group received supervised training program for eight weeks while the control group were prescribed the activities and exercised they had to perform. During the controls carried out after two months, an increase was found in the MET values of the both groups; however, aerobic capacity gains were more observed in the training group [23]. Golabachi et al. studied the effects of CR on functional capacity in MI patients. The patients were divided into two groups as the training group and the control group. The controls carried out after two months revealed that the functional capacity (MET) increase was statistically significant in the training group[24]. Contrary to the literature, we took into consideration not the MET but the AT values to evaluate the functional capacity. At the end of our study, the increase in AT values was similar in both groups.

In a study conducted in 2010, the efficiency of home-based programs was equal to that of centre-based programs in low-risk cardiac patients[25]. Inconsistency with the literature, the reason of not finding any difference between the groups in our study could be related to the fact that those in the home exercise group had the lower risk. In a review published in two thousand six, it was reported that home-based CR was not significantly inferior to centre-based rehabilitation programs for low-risk cardiac patients [26]. A study comparing home-based and centre-based CR programs were performed in Turkey, too. Daskapan et al. compared home-based and centre-based CR programs in patients with chronic heart failure and found that both of the programs increased the exercise capacity. They stated that home-based exercise training could be a training alternative to stable chronic heart failure patients preferring not to participate in a centre-based program [27]. In our study, both groups have a similar influence on cardiopulmonary parameters and exercise capacity of the patients with previous MI.

In a Cochrane systematic review published in 2016, when compared with no exercise control, exercise-based CR shown that reduces the risk of cardiovascular mortality but not total mortality [28].

The limitations of our study were having no standard home-based exercise program, access problems, occupational status, having no motivation, socio-economical status and having a

limited number of patients in both groups due to being a recently founded CR unit with a limited number of physicians.

In the future studies, the extent to which the quality of life changes, the duration of positive effects of exercise and whether the exercise programs are performed or not by the patients can be studied by following-up the patients for a longer period of time. Moreover, studies employing more standardized home-based exercise programs are required. Additional studies with larger populations, longer follow-up terms and patients homogenized based on risk factors would yield better results on this issue.

CONCLUSION

In this study, both groups have a similar influence on cardiopulmonary parameters and exercise capacity of the patients with previous MI. Home-based exercise programs can be a good alternative for patients with low or moderate risk who can't attend hospital-based exercise programs.

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