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Effect of Combined Resistive and Aerobic Exercise versus Aerobic Exercise Alone on Coronary Risk Factors in Obese Coronary Patients

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Abstract

Objective: To study the effect of combined resistive and aerobic training versus aerobic training alone on coronary risk factors in obese coronary patients.

Design: Randomized clinical trial.

Setting: Outpatient setting.

Participants: 50 coronary artery disease patients completed the study and were randomized to group I aerobic exercise (n=25), and group II combined resistive and aerobic exercise (n=25).

Interventions: All patients had dietary counselling, stress management and aerobic exercise 3 times per week for 36 sessions. Group II added resistive exercise from the 18th session. All exercises were telemetry-monitored.

Results: Strength gains for group II were greater than for group I on the three resistance machines (P<0.01). Percent body fat was reduced for group II after training (P<0.01) with significant difference in between groups (P<0.01). The relative gain in lean mass was greater in group II (P=0.0006). Group II only had decreased cholesterol, triglyceride, and low density lipoprotein (P<0.05). High density lipoprotein significantly increased in both groups (P<0.05). All cardiovascular conditioning parameters significantly diminished in both groups after training (P<0.05). Group II had lower exercise systolic blood pressure (P<0.05) and relatively greater improvement in average work load (P=0.0000).

Conclusions: Combined resistive and aerobic training give better control of coronary risk factors particularly lipid profile and weight in obese coronary patients.

Introduction

The prevalence of obesity in patients with coronary artery disease approaches 40% and obesity contribute to the atherogenic potential of diabetes, hypertension, and hyperlipidemia and has significant adverse effects on physical activity level [1,2]. Comprehensive cardiac rehabilitation program has evolved to improve physical function and control cardiovascular risk factors [3,4]. The effects of aerobic exercise training have been extensively studied in patients with coronary artery disease [5-8]. In order to improve muscle strength and help to return to work, resistive exercise was cautiously added to aerobic exercise with more increase in muscle strength and maximal power output than with aerobic exercise alone [9-16]. A few recent resistance training studies with cardiac patients also have demonstrated additional beneficial body composition changes such as decreased percentage body fat and increase lean mass [17,18]. The effects of resistive exercise on serum lipid profile remains unsettled with improvement in lipid measure in some studies [19-22] and no effect on others [23-26].

Purpose: The purpose of this study was to compare the effects of combined aerobic and resistive exercise versus aerobic exercise alone on coronary risk factors among obese coronary patients.

Methods

Patients

The study protocol was approved by the institutional review board at Montefiore Medical Center/Albert Einstein College of medicine and informed consent was obtained from the patients before their participation. Consecutive patients entering a cardiac rehabilitation program at Montefiore Medical Center were screened to determine if they met the inclusion criteria as follow:

- All patients had recent documented coronary artery disease (less than 6 months). This means documented stable angina pectoris, Myocardial infarction, status post stent placement or coronary artery bypass surgery.
- Had undergone graded exercise test prior to their referral.
- They were obese according to body mass index as follows: ≥27.3 Kg/m² in women, ≥27.8 Kg/m² in men [27].

- They agreed to maintain the dosage of medications that may affect lipid level as lipid lowering medications, β blocker, diuretics, estrogen, α blocker, and calcium antagonist at stable dose during the course of the study.

Patients were excluded from the study if they had any one of the following conditions:

- Uncontrolled dysrrhythmias
- Unstable angina
- Uncontrolled hypertension defined as systolic blood pressure ≥200, or diastolic blood pressure ≥110 mmHg
- Major orthopedic limitations that precluded resistance training
- History of congestive failure, and ventricular or aortic aneurysm.

All patients had not sustained any cardiac episode within two weeks prior to enrolment. Patients who were not excluded by the above criteria were invited to participate in the study. Fifty-seven patients (26 men and 29 women) were enrolled.

Procedure

Initial evaluation and study design: All patients have an initial medical history, exercise and occupational history and cardiovascular and musculoskeletal physical exam. Then all patients underwent baseline physical tests. Dietary counselling and stress management were carried out for all patients. All medications including lipid lowering medication were recorded and kept stable all through the study. All the physical tests were performed at Montefiore Medical Center by the same physician. After the baseline physical tests, patients were randomized into two groups according to their social security number endings, those with odd ending constituted group I performing aerobic exercise only. Those with even number constituted Group II performing combined aerobic and resistive exercise. All patients were oriented to all the aerobic and resistance machines. They were taught how to use the machines and how to apply the telemetry monitor to themselves. Telemetry monitored-Exercise was carried out 3 times per week for 36 sessions. Heart rate was recorded at rest and during each exercise modality. Blood pressure was recorded before, during and after exercise. Aerobic exercise intensity prescription was based on the referral stress test results.

Baseline physical tests

Body composition measurements: Body weight and sum of skin folds measured by lange calipers or Skyndex [3,28] had been measured and then body mass index, body density, percent body fat and lean body mass were calculated for all patients [28].

Lipid profile testing: Blood lipid studies were performed after a 12 hour fasting, including total cholesterol, Triglyceride (TG), High Density Lipoprotein (HDL), and Low Density Lipoprotein (LDL).

First exercise monitoring session data: Measurement of Blood Pressure (BP), Heart Rate (HR), Rate Pressure Product (RPP) which is the product of Systolic Blood Pressure (SBP) and resting heart rate (RHR) divided by hundred, ECG waveform evaluation for ischemia and /or arrhythmia and workload on each aerobic exercise modality [28]. Blood pressure and HR were measured at rest, during exercise (during the aerobic phase of exercise), then at the end of the session. The RPP was calculated at rest.

The patients performed aerobic exercise using different modalities namely; bike, treadmill, Nu-step machine, rower, stair master, and arm-leg. The order, in which the exercise modalities were used, was recorded, to be repeated in the same order during last exercise session data measurement. The duration and intensity of each effort performed on each individual machine were recorded, as well as, the Borg scale values (perceived exertion rating) [29]. Any symptoms during exercise were noted in details. At the end of the first exercise session, the average estimated metabolic equivalent MET performed by the patient from the individual MET on each exercise modality using the standardized tables. Average exercise HR was calculated by calculation of the mean HR performed during exercise on each exercise modality. All these data (RHR, RSBP, Resting diastolic BP, RPP, exercise SBP, exercise DBP, average exercise HR, average exercise MET level) were kept for each patient in both exercise groups to be compared with similar data obtained from last monitored exercise session at the end of the study.

Evaluation of muscular strength by one-Repetition Maximum (1-RM): The assessment of One Repetition Maximum (1-RM) was performed by all subjects on Cybex multi-station weight system to establish initial muscular strength level. This machine used fixed weight selection and provides both eccentric and concentric muscular action. The exercise machines used for testing subjects were chest press, leg extension, and leg curl machines. The majority of these exercises are multi-joint movements and all are representative of lower and upper body strength needed to perform daily living activities.

A 1-RM is defined as the weight that can be lifted no more than one time with "acceptable form" [30,31]. Acceptable form means that exercise is performed primarily by the specified muscle groups without the use of momentum or any changes in body composition, other than those directly resulting from the movement of the weight, during the exercise motion period. Patients received detailed instructions and performed each exercise several times at a very low resistance to enhance familiarization and warm up. Proper breathing was emphasized to avoid valsalva maneuver. A light warm up of 5 to 10 repetitions with light weight was performed [30,31].

Exercise programming

Aerobic exercise program: The aerobic exercise portion of the training program was the same for both groups, and consisted of 4 intervals, 5 minutes each on a combination of aerobic exercise equipments (bike, treadmill, Nu-step machine, rower, stair master, and arm-leg. The patients performed five minutes of warm-up and cool down before and after aerobic exercise respectively. In addition, 5 minutes of stretching exercise at the end of the session. Intensity was based on referral stress test results and individually prescribed. That is the target heart rate to be maintained during exercise at 40-60% of the heart rate range added to the resting heart rate. The heart rate range is the difference between the peak heart rate on the stress test and the resting rate. The heart rate was checked every exercise, and used periodically to update the exercise loads as needed to maintain the appropriate intensity. In addition to the use of Borg scale [29].

Combined aerobic and resistive exercise program: For those patients assigned to combined aerobic and resistive exercise program (Group II). During the first 18 sessions, aerobic exercise was carried out exactly similar to the above mentioned aerobic exercise program. Then resistive exercise was added to the aerobic program.1-RM was re-evaluated before the start of resistance program to make sure that accurate calculation of 60% 1-RM is obtained since the aerobic exercise components could lead to some improvement in the muscle strength. The machines used were chest press, leg extension (knee

extension), and leg curl (leg flexion). Patients had performed 2 sets of 8-12 repetitions for each machine. The 1-RM measurement had been repeated every two weeks after the addition of the resistive program so that the intensity of the resistive exercise had been kept at a constant level. Exercise had continued for the remaining 18 sessions.

Final evaluation

All patients had the baseline physical tests repeated after 36 sessions i.e. at the end of the study; namely body composition measurements, lipid profile, muscular strength by 1RM, and last exercise session data; similar to first exercise session data. The same data were recorded namely; RHR, RBP, RPP, average exercise HR, average exercise BP and average exercise MET level. Exercise was performed on aerobic modalities in the same order performed during the first exercise session.

Statistical analysis

Data from each group were compared with its own baseline information at the end of the study. T test for independent samples was used. T-test was considered significant if P ≤ 0.05. Analysis of Variance (ANOVA) was used to analyse difference between groups after training with baseline scores used as covariates and group used as the independent variable. Pearson's product moment correlation tests were done to detect if there is correlation between body composition change and lipid profile changes in the studied patients. Significant correlation was considered if r ≥ 0.23.

Results

Baseline characteristics

Table 1 presents baseline characteristics for the two groups of patients who complete the 36 training sessions. There were no differences between the two groups at baseline for age, ratio of male to females, cardiac events. All patients were non-smoker. Baseline value for body composition, muscular strength, lipid profile,

cardiopulmonary data were presented in Table 2,3,4 and 7 respectively. There were no differences between the groups at the baseline for body composition, strength, or lipid profile. However despite randomization of assignment to groups the mean RHR and average exercise HR were significantly lower in group II than in group I (P<0.05). In addition, the mean average work load (MET) on different aerobic machines at baseline were significantly lower in group II patients at baseline (P<0.05).

	Group I "n=25"	Group II "n=25"
Age (years)	63.059 ± 13.34	57.88 ± 13.27
Male (n,%)	13 (52.0%)	11 (44.0%)
Female (n,%)	12 (48.0%)	14 (56.0%)
Height (m) mean	1.608 ± 0.093	1.653 ± 0.091
Cardiac event (n,%)/Coronary artery bypass graft	14 (56.0%)	13 (52%)
Myocardial infarction	6 (24%)	5 (20%)
Angina	2 (8.0%)	3 (12.0%)
Angioplasty	3 (12.0%)	4 (16.0%)

Table 1: Baseline characteristics. Data are presented as mean ± Standard deviation.

Body composition

Body composition data are presented in Table 2. There were no significant changes in the body weight or body mass index after training for either exercise group. There was trend toward increase lean mass in the combined training group (P=0.098). There was significant reduction of percent of body fat in the combined training group (P<0.0001). ANOVA analysis revealed that patients in the combined training group lose more fat (P<0.0001) and gain more lean mass (P<0.0006) than those in the aerobic training group.

	Aerobic training (Group I)			Combined training (Group II)			
	Baseline	**Final**	**Δ%**	**Baseline**	**Final**	**Δ%**	**P-value**
Body weight (Kg)	90.6 ± 15.3	89.7 ± 13.7	-1	95.1 ± 13.9	92.6 ± 14.0	-2.6	0.0031**
Sum of skin folds (mm)	95.4 ± 19.3	86.4 ± 18.6	-9.4	99.2 ± 2	75.9 ± 16.4	23.6*	0.0001**
Body density	1.029 ± 0.01	1.034 ± 0.01	0.5	1.029 ± 0.01	1.04 ± 0.01	1.2*	0.0001**
Percent Body fat	30.9 ± 4.2	28.6 ± 4.4	-7.2	31.2 ± 5.0	25.3 ± 4.9	-18.8±	0.0001**
Lean body mass (Kg)	62.2 ± 7.9	63.7 ± 7.7	2.4	65.2 ± 9.4	69.0 ± 10.4	5.7	0.0006**
Body mass index	33.549 ± 2.8	33.4 ± 2.5	-0.6	34.9 ± 4.7	33.9 ± 4.7	-2.7	0.0031**

Table 2: Body composition data. Data are presented as mean ± standard deviation, P value column indicate difference between groups. * Indicate significant change from baseline (P≤0.05). ± indicate significant change from baseline (P≤0.01). ** Indicate significant between groups (P≤0.01).

Muscular strength

Percentage changes in muscle strength for the two groups are shown in Table 3 for each of the three exercises. The combined training group significantly increased strength in all 3 machines

(P<0.05). While the aerobic training group showed trend toward increase but not significant. Group II had greater improvement in strength when compared with group I (P<0.0001). The percentage change in strength ranged from 9-12% in the aerobic group and 42-54% in the combined training group.

	Aerobic training (Group I)			Combined training (Group II)			
1-RM (lb)	**Baseline**	**Final**	**Δ%**	**Baseline**	**Final**	**Δ%**	**P-value**
Chest press	55.9 ± 29.3	61.2 ± 31.2	9.5	77.8 ± 64	111.0 ± 65.4	42.7*	0.00001 ±
Leg extension	65.9 ± 36.7	76.2 ± 35.5	15.6	84.0 ± 44.7	119.6 ± 49.0	42.4*	0.00001 ±
Leg curl	56.2 ± 29.0	62.9 ± 32.3	12	65.0 ± 32.1	99.8 ± 35.7	53.5*	0.00001 ±

Table 3: Changes in Muscular Strength (lbs). Data are presented as mean ± standard deviation P value column indicate difference between groups. *Indicate significant increase compared to baseline (P ≤ 0.05). ± indicate significant difference between groups (P ≤ 0.01).

Lipid profile

The combined training group showed significant reduction in cholesterol, TG and LDL, as well as significant increase in HDL (P<0.05) (Table 4). The aerobic training had only significant increase in HDL (P<0.05). ANOVA revealed only greater reduction in cholesterol level in group II (P<0.05).

	Aerobic training (Group I)			Combined training (Group II)			
	Baseline	**Final**	**Δ%**	**Baseline**	**Final**	**Δ%**	**P-value**
Cholesterol	175.4 ± 41.1	158.2 ± 29.2	-9.8	190.7 ± 41.5	160.6 ± 22.5	-15.8	0.02+
Triglyceride	165.8 ± 120.7	140.4 ± 74.2	-15.4	186.5 ± 82.5	142.4 ± 45.9	-23.6	0.09
HDL	38.0 ± 6.6	47.1 ± 7.1	24	39.2 ± 9.5	48.2 ± 9.7	22.7	0.4
LDL	103.0 ± 35.4	95.0 ± 23.8	-7.8	111.6 ± 29.0	93.9 ± 18.1	-15.9	0.1

Table 4: Changes in Lipid Profile. Data are presented as mean ± standard deviation P value column indicate difference between groups. + Indicate significant difference between groups (P ≤ 0.05).

	Body weight	Sum of skin folds	Body density	% body fat	Lean mass	BMI
Cholesterol						
r	0.207	0.325	0.434	-0.433	0.068	0.351
p	>0.05	<0.05*	<0.05*	<0.05*	>0.05	<0.05*
Triglyceride						
r	0.201	0.402	-0.396	0.397	0.06	0.502
p	>0.05	<0.05*	<0.05*	<0.05*	>0.05	<0.05*
HDL						
r	-0.072	-0.156	0.008	0.004	0.069	0.134
p	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
LDL						
r	0.178	0.341	-0.421	0.419	0.03	0.461
p	>0.05	<0.05*	<0.05*	<0.05*	>0.05	<0.05*

Table 5: Correlation between lipid profile and body composition changes in group I. correlation coefficients were r ≥ 23. *Indicate significant increase compared to baseline (P ≤ 0.05). p value of T test compare pre and post program for each factor among the same group.

Correlation between body composition changes and lipid profile

Table 5 and 6 presents the association between changes in body composition components and lipid profile in both groups. The correlation coefficients were r ≥ 0.23. Cholesterol correlated with percent body fat in group I (r=0.43) as well as in group II (r=0.26). It was inversely correlated with lean mass in group II only (r=0.28). LDL significantly correlated with percent body fat in both groups I & II (r=0.42, 0.24 respectively). HDL was negatively correlated with body weight (r=0.35) and positively with lean mass (r=0.31) in only group II. Triglyceride correlated with percent body fat (r=0.39) and body mass index (r=0.50) in only group I.

	Body weight	Sum of skin folds	Body density	% body fat	Lean mass	BMI
Cholesterol						
r	0.16	0.153	-0.264#	-0.263#	0.277#	0.148
p	>0.05	>0.058	<0.05*	<0.05*	<0.05*	>0.05
Triglyceride						
r	0.09	0.139	-0.202	0.201	0.606	0.144
p	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
HDL						
r	-0.350	-0.011	0.071	0.267#	0.310#	-0.167

p	<0.05	>0.05	>0.05	>0.05	<0.05*	>0.05
LDL						
r	0.135	0.158	-0.243	0.245	0.228	0.121
p	>0.05	>0.05	<0.05*	<0.05*	>0.05	>0.05

Table 6: Correlation between lipid profile and body composition changes in group II. r=correlation coefficient correlation coefficients were ≥ 23. p value for T test compare pre and post program for each factor among the same group. * indicate significant change from baseline (P ≤ 0.05).

Cardiovascular and exercise conditioning data

Table 7 presents data from first and last exercise monitored session. After training the resting heart rate, resting systolic blood pressure, resting diastolic blood pressure, rate pressure product significantly decreased in both groups (P<0.05). The relative improvement between groups was not different. The average MET significantly increased after training in both groups (P<0.05). The average exercise heart rate, mean exercise systolic blood pressure, mean exercise diastolic blood pressure significantly decreased after training in both groups (P<0.05). ANOVA revealed greater improvement in average work load estimated by MET (P<0.0001) as well as exercise systolic blood pressure in the combined training group than in the aerobic training (P<0.05).

Aerobic training (Group I)			Combined training (Group II)			
First monitored exercise session	Last monitored exercise session	Δ%	First monitored exercise session	Last monitored exercise session	Δ%	P-value
83.8 ± 7.5	77.4 ± 6.1	-7.6*	75.6 ± 7.2	69.4 ± 6.3	-8.1*	0.0011*
139.6 ± 6.0	129 ± 7.0	-7.0*	137.7 ± 12.9	128.0 ± 8.4	-7.0*	0.001*
77.1 ± 7.8	70.6	-8.4*	80.3 ± 8.0	73.1 ± 5.6	-9.0*	0.00026*
117.1 ± 12.6	100.5 ± 9.7	-14.2*	103.9 ± 12.5	88.7 ± 8.3	-14.6*	0.0003*
3.0 ± 0.5	4.1 ± 0.8	36.1*	2.6±0.4	4.4 ± 0.6	67.2*	0.0001*

Table 7: Cardiopulmonary exercise tolerance and efficiency. HR=Heart Rate, SBP=Systolic Blood Pressure, DBP= Diastolic Blood Pressure, RPP=Rate Pressure Product. Data presented mean and SD, * indicate significant change from baseline (P ≤ 0.05).

Adherence

Seven patients had dropped out from the study (3 females, 4 males) and were excluded from the statistical analysis. Those patients were not able to continue the exercise program due to transportation problems, job related problems and insurance coverage problems. There was no incidence of any injury related to exercise programs.

Discussion

In this study, obese coronary artery patients who performed combined resistive and aerobic training showed significant reduction in percent of body fat. The increase in lean mass, although not significant, was higher in the combined training group compared with aerobic training alone. The relative improvement of all body composition measurements (body weight, body mass index, percent body fat and lean mass) were significantly higher in the combined training group than in the aerobic training alone. The combined training resulted in significant reduction in the level of cholesterol, triglyceride, and LDL levels and significant increase in HDL level. Total cholesterol level and LDL level significantly correlated with percent of body fat in both groups. In the combined training group the lean mass was inversely correlated with cholesterol level and positively correlated with HDL level. Patients who performed combined resistive and aerobic training substantially increased their muscular strength while patients performing the aerobic training improved strength by modest amount. This improved strength in the aerobic only training group may have been the result of either habituation to strength testing protocol, true strength adaptation to the resistive component in the cycling and rowing aerobic activities. The additional resistive training resulted in more than three folds higher gain when the results averaged across the three resistive exercise stations used.

Body composition

In the present study, patients performing combined training showed significant reduction of percent of body fat. The increase of lean mass although not significant was higher in the combined training group (% Δ5.7) than in aerobic training alone (% Δ2.4). Other studies have shown resistive training to be effective in decreasing body fat and increasing lean mass in women in their late twenties [32], pre-menopausal [19,20] as well as after sixties [33]. Similar to our results, Pierson et al. [34] found significant reduction of percent body fat and increase lean mass in coronary patients performed combined resistance and aerobic exercise for six months compared to those performed aerobic exercise alone. In their study the resistive training program started in the third week of cardiac rehabilitation program (2 sets of 12-15 repetition of 40% 1RM) on different weight machines, 3 times per week for 6 months. The increase in lean mass was significant in their study, in contrast to our study, where the level of increase did not reach statistical significance. This might be explained by the longer duration of that study (6 months in contrast to only 3 months in our study). In addition to the higher number of resistance exercise machines used in that study, 7 machines compared to only 3 machines in our study. Another factor might be the different methodology for body composition analysis (skin fold in our study, dual energy radiographic absorbiometry in that study). In a study by Beniamini et al. [18] cardiac patients performing combined resistive and aerobic exercise for 12 weeks lost more body fat and tended to gain more lean mass than a group of patients performing aerobic plus flexibility exercises. Wosornu et al. [25] compared the effect of strength and aerobic training on exercise capacity and lipids after coronary artery bypass surgery. They found significant reduction in percent body fat in patients who performed strength training after coronary bypass surgery. In contrast, no change after aerobic exercise. Campbell et al. [35] found decreased fat mass and increased lean mass following 12 weeks of resistance training in older adults. Results from their study showed an increased resting metabolic rate such that the mean energy intake required for body weight maintenance was increased by 15% in weight training subjects. An increased resting metabolic rate with weight training may explain the greater loss of body fat in resistive training subjects in the present study.

Other studies did not report significant change in body composition in cardiac patient after high intensity training [11] and in men at high risk for coronary heart disease [23,24].

Lipid profile

In the present study, combined training group showed significant reduction of total cholesterol, triglyceride, and low density lipoprotein. In addition to, significant increase in high density lipoprotein. Cardiac rehabilitation and exercise training usually result in small but statistically significant improvement in lipids [5,27,36]. Those studies examined the effect of traditional cardiac rehabilitation aerobic exercise program on the lipids. Other studies demonstrated improvement of lipid profile after resistance training in sedentary women [20], healthy premenopausal women [19,20], and middle aged volunteer men [21]. Goldberg et al. [22] studied a single group of men and women and reported decrease total cholesterol, low density lipoprotein cholesterol, triglyceride and decreased ratio of LDL/HDL after 16 weeks of resistance training at 84% of 1-RM.

Other studies disagree with our results and found no change in lipid profile after resistance training performed by middle aged men at high risk for coronary heart disease [23,24], coronary bypass patients [25], and obese women [26].

Muscular strength

A significant improvement in strength was found in patients performing combined training with mean percent increases ranging from 42-54% depending on the specific exercise. This improvement was markedly greater than strength changes observed in the aerobic group. This finding agrees with other studies in which cardiac patients have been administered resistive training to increase muscular strength [12-18] with similar magnitude of improvement. Pierson et al. [34] reported mean percent strength increase 44 to 81%. Beniamini et al. [18] reported mean percent increase of 45% to 95% in male cardiac patients who trained for 12 weeks with high intensity resistance training. The present study documents strength improvement after resistive exercise in obese patients with coronary artery disease.

Exercise capacity and cardiovascular conditioning

Even though patients in this study were randomly assigned to training groups, the combined training had significantly lower average exercise heart rate and mean workload (MET) on different aerobic machines at baseline. After training both groups have significant improvement in MET level. The relative improvement in MET was higher in the combined training group. In our study we did not measure VO_{2max} directly, instead we had measured the workload on each exercise machine, calculated the average MET during first and last exercise session (MET level) and we compared between those values within each group and between groups. This design was applied in the cardiac rehabilitation unit of Albert Einstein College of Medicine. There was no similar way within the literature; instead the previous studies usually depend on the data from the graded exercise test. The effect of circuit weight training on aerobic capacity in normal subjects is, equivocal. Studies have shown no improvement14or slight increases in maximal oxygen consumption up to 11% [37,38]. Previous studies in cardiac patients have suggested slight improvement in aerobic capacity with resistance training [39]. In Pierson's study [34]

the VO_{2max} significantly increased within both groups after training but the relative improvement between groups was not different.

In our study, both groups showed significant cardiovascular conditioning manifested by significant reduction of the heart rate, systolic, diastolic blood pressure, as well as the rate pressure product at rest and during exercise. No difference was found between groups when the resting and exercise data were compared except for the relative lower mean exercise systolic blood pressure in the combined training group. This means that the combined training lower exercise systolic blood pressure more than the aerobic training alone. In contrast to these results, Pierson et al. [34] demonstrated decreased heart rate and rate pressure product at rest and during exercise in the combined training group only.

Study Limitation

We did not repeat exercise stress test at the end of the study. We rather depend on comparison between data of the first and last exercise monitored session for each patient in both groups. In between groups, data analysis was also carried out. Also we can't ask the patient to stop the lipid lowering medication completely but rather we asked them to make the dose fixed all through the study. So the results of change in lipid profile in favour to be secondary to exercise.

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