

The effect of resistance exercise on mean blood pressure in the patients referring to cardiovascular research centre

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ABSTRACT

Background: One of the most important risk factors for cardiovascular disease is hypertension. 1 billion people in the world and 25–35% of the adult population in Iran suffer from hypertension. Despite the emphasis on medicational treatments, non-medicational treatments and modification of lifestyle, including physical activity and exercise, are important for the control and treatment of hypertension and lead to a reduction in cardiovascular diseases. Among the various types of exercises, resistance exercise has been considered important by the cardiologists. The present study investigates the effect of resistance exercise on mean blood pressure in the cardiovascular patients.

Materials and Methods: In a randomized clinical trial, 40 patients admitted to the rehabilitation unit of cardiovascular research center were assigned to study and control groups. Demographic data were collected. Their blood pressure values were measured and recorded once 1 day before the beginning of the intervention and another time 1 day after its completion. All study subjects participated in two 45–60 min exercise sessions for eight straight weeks. The control group followed routine rehabilitation unit protocol that was aerobic exercise. The study group subjects performed resistance exercise in addition to routine exercise. The weight was determined in the first session of the intervention. At the beginning, the number of the repetitions in the range of motion was 10, which was increased gradually to 15. After it reached 15 repetitions, the amount of weight was increased by 3–5% and the number of sets increased.

Results: One day before the beginning of the intervention, mean systolic blood pressure was 128.21 (15.39) mmHg in the study group and 120.00 (20.51) mmHg in the control group. Mean diastolic blood pressure was 82.50 (9.35) mmHg in the study group and 82.00 (13.11) mmHg in the control group. There were no differences between the groups in terms of mean systolic and diastolic blood pressure ($P > 0.05$). After the end of the intervention, mean systolic blood pressure values were 116.42 (7.18) mmHg and 112.00 (12.60) mmHg in the study and control groups, respectively. There were no significant differences between the groups ($P = 0.24$). Mean diastolic blood pressure values were 81.78 (7.99) mmHg in the study group and 78.25 (12.48) mmHg in the control group. There was no significant difference between the groups ($P = 0.35$). At the end of the intervention, mean systolic blood pressure in the study group decreased significantly ($P = 0.02$).

Conclusions: In the present study, the effect of resistance exercise on mean systolic blood pressure showed a significant difference, caused by the aerobic exercise.

Key words: Blood pressure, coronary artery disease, resistance training

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INTRODUCTION

Cardiovascular diseases (CVDs) have the highest mortality rate in the world, and will remain the main cause of mortality until 2020. In Iran, CVDs are the main cause for mortality among adults (46% of all mortalities).^[1] One of the most important risk factors for CVD is hypertension which has afflicted about 1 billion people worldwide.^[2] Over 7 million people die annually

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of direct complications of hypertension. In Iran, 25–35% of the middle-aged people suffer from hypertension. Recent statistics show that among the non-communicable diseases, hypertension is the first cause of mortality in Iran and the second in the world.^[3] Besides the emphasis on medication methods, non-medication methods and modification of lifestyle, including physical activity and exercise, are of great importance to control and treat hypertension, and consequently, reduce CVDs.^[2] Among the different types of physical exercises (aerobic, stretching, flexibility, resistance), resistance exercises have been considered important by the cardiologists.^[4] Resistance exercise is a type of exercise in which all movements are made against an imposed force or pressure.^[5] One of its advantages is prevention of muscles' mass atrophy and their decreased function. Contrary to aerobic exercises, resistance exercises involve more muscle mass during a period of exercises and increase the ability among the patients with coronary artery diseases to do their everyday activities through improvement or preservation of muscular power and reduction of blood pressure (BP) by increase of resting metabolism and weight loss.^[6] Although exercise is a sort of physical activity and movement, and is considered as a part of nursing interventions, nurses do not pay adequate attention to physical exercise in their care.^[7] They have not accepted and developed physical exercise yet, play a role just in the clinical setting, and participate less in rehabilitation.

Researchers' experiences indicate that hypertensive patients' physical activity and exercise regimen is not followed up after their discharge and the patients are left alone. Although resistance exercise is also a part of lifestyle modification program and also a non-medication treatment for hypertension, it is not welcomed by this group of patients and applied for them by the nurses. It should be noted that control of hypertension, a major risk factor for CVD, can highly diminish coronary artery diseases and there are controversial results about the effect of resistance exercise on hypertension (BP changes).^[8-11] So, the present study aimed to investigate the effect of resistance exercise on mean BP in the patients referring to Cardiovascular Research Center.

MATERIALS AND METHODS

This clinical trial (No. IRCT201322112551N1), which has been registered in Iranian Clinical Trial Database, was conducted on the clients who were in pre-hypertension stage and stage 1 of hypertension (systolic BP between 120 and 159 mmHg and diastolic BP between 80 and 99 mmHg), referring to cardiac rehabilitation unit, taking anti-hypertension medication, and having their coronary arteries' involvement diagnosed by angiography. Also, 2 months should have passed from their myocardial infarction (MI), 10 days their coronary

artery angioplasty, and/or 3 months should have passed after their coronary bypass surgery. Exclusion criteria were smoking cigarette, playing an athletic sport, attending a sport program (event) 3 months prior to the study, being absent for more than three sequential sessions in the rehabilitation program, incidence of severe health problems, and limitation in doing physical exercises. Forty qualified subjects were enrolled in the study through convenient sampling. It was conducted with the supervision of a cardiologist. After giving necessary explanations about the various stages of the research, the required conditions for BP measurement, and making no change in their consumed medications during the intervention, a written informed consent was obtained from them. Through use of random number table in which the direction of movement had been already determined, and based on even or odd number, the subjects were assigned to study and control groups ($n = 20$ in each group). As at least 6 weeks are needed for adaptation with CVDs,^[8] the length of study was considered 8 weeks. Intervention was conducted in the form of 45–60 min sessions, twice a week^[12] (8–12 AM) for 8 weeks in the rehabilitation unit of the cardiovascular research center. The type of the exercises and movements, performed in the sessions, was selected based on articles and indications of the experts in this context. Firstly, the questionnaire of demographic characteristics, consumed medications, and history of physical exercise was filled. Subjects' BP was measured from both their hands held at the heart level, 1 day prior to exercise, after making them sit on a chair calmly, with their feet on the ground. They should not have had coffee or tea in the past 30 min, and avoided speaking due to a possible false BP increase. Then, their mean BP levels were recorded. A calibrated Richter sphygmomanometer with appropriate size of cuff, its reliability had been established based on test-re-test, with 40% width of arm circumference and length of 80% of arm circumference, being fastened 2.5 cm above the brachial artery.^[13] This procedure was repeated 1 day after the last session of the intervention.

Subjects' height and weight were measured with light clothes by a standard tape meter (wearing no shoes) and a calibrated scale before the intervention, and then recorded. The subjects in the control group just attended a routine exercise session in the rehabilitation unit of the cardiovascular research center, which included running or treadmill with an average speed of 4 km/h and cycling on a stationary bicycle for 15 min. In the study group, in addition to aerobic exercises, resistance exercise was also performed. In the first session, the target weight was determined based on the heaviest weight each subject could lift for 12–15 times in the expected range of motion.^[14] In all sessions, there were warm-up, exercise, and cool-down stages. Warm-up and cool-down stages were conducted with stretching exercises for 10–15 min.

The exercise included resistance exercise that was performed for 20–25 min, in addition to aerobic exercise. Resistance exercise was performed by use of light weights in the range of motion of the elbow, shoulder, and knee joints. The number of repetitions in the range of motion was initially 10, and then was gradually increased to 15. After the end of each set with 15 repetitions, the weight was increased by 3–5%.^[12] In the second session, each subject held his/her target weight in hand and performed one set of side lateral, front, and overhead raise, overhead triceps extensions, alternating biceps curls and shoulder press, and weight squad with 10 repetitions. In sessions 3–7, a set of the above-mentioned exercises was repeated for 11 and 15 repetitions, respectively. In the 8th session, both the number of the sets and the weight were increased (by 3–5% of the previous weight) in such a way that two sets of the above-mentioned exercises were performed with 10 repetitions, with a rest period of 1 min between the sets. In sessions 9–13, two sets of the above resistance exercises were performed with 11 and 15 repetitions in each session, respectively, and a 1 min rest period between the sets. In session 14, the number of the sets and the weight were increased again. In sessions 15–16, three sets with repetitions of 11–12 times were performed. The correct way of exercise and prevention of Valsalva maneuver were explained to the subjects.^[12]

To prevent Valsalva maneuver, the weight was lifted within 2 s during exhalation and was put down within 4 s during inhalation. All the clients referring to the rehabilitation center attended proper nutrition education and psychiatry counseling sessions. After the end of the study, the related exercise program was taught to the subjects in the control group.

The data were analyzed by SPSS version 20. To compare intragroup BP levels, paired *t*-test and for intergroup comparison, independent *t*-test were used. To investigate the means of quantitative variables of demographic characteristics in the two groups, independent *t*-test and for qualitative variables, Chi-square and Mann–Whitney tests were used. Significance level was considered at $P < 0.05$ in all statistical tests.

Ethical considerations

The study protocol was approved by the Research Ethics Committee of Isfahan University of Medical Sciences.

RESULTS

Forty subjects, out of 42 who enrolled in the research, completed the study. Demographic characteristics of the subjects of both groups are presented in Table 1. Independent *t*-test, Chi-square, and Mann–Whitney tests

showed no significant difference in subjects' age, sex, marital status, a positive family history, history of diseases, and education in the two groups ($P > 0.05$).

Independent *t*-test showed no significant difference in the mean systolic and diastolic BP levels before intervention in the two groups ($P > 0.05$). After intervention, paired *t*-test showed a significant reduction in the mean systolic BP in the study group ($P = 0.02$), but the mean diastolic BP showed no significant difference ($P > 0.05$). In the control group, mean systolic and diastolic BP levels showed no significant difference ($P > 0.05$) [Table 2]. Independent *t*-test showed no significant difference in the systolic ($P = 0.24$, $t = 1.18$) and diastolic ($P = 0.35$, $t = 0.93$) BP levels between the two groups (mean BP levels after intervention).

DISCUSSION

In the present study, resistance exercise significantly decreased systolic BP in the study group, but there was no significant difference between two groups. As indicated in

Table 1: Comparison of demographic characteristics in two groups of study and control

Group Demographic characteristics	Relative frequency (%)		Statistical tests (P)
	Study	Control	
Sex			
Female	14.3	45	$\chi^2=7.14 >0.05$
Male	85.7	55	
Married			
Married	100	95	$\chi^2=30.11 >0.05$
Widowed	0	5	
Education			
Illiterate	0	25	$Z=103.50 >0.05$
Primary	28.6	30	
Middle school	14.3	5	
High school	7.1	0	
Diploma	35.7	25	
Associate degree	0	0	
Bachelor's degree and higher	14.3	15	
Diseases history			
Hypertension	85.7	60	$\chi^2=4 >0.05$
Diabetes	35.1	25	
Dyslipidemia	7.1	5	
Combination of three diseases	14.3	25	
Positive familial cardiac diseases history	85.7	60	$\chi^2=7.41 >0.05$
Age (mean and SD)	57.5 (8.62)	62.80 (7.81)	$t=1.86 >0.05$

There is no significant difference in demographic characteristics in the two groups of study and control. SD: Standard deviation

Table 2: Comparison of mean BP in the study and control groups through paired *t*-test

Groups Variables	Study				Statistical tests	Control				Statistical tests
	One day before intervention		One day after intervention			One day before intervention		One day after intervention		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Systolic BP	128.21	15.39	116.42	7.18	$t=2.56$ $P<0.05$	120.00	20.51	112.00	12.60	$t=2.01$ $P>0.05$
Diastolic BP	82.50	9.35	81.78	7.99	$t=0.23$ $P>0.05$	82.00	13.11	87.25	12.48	$t=1.23$ $P>0.05$

There is significant difference in systolic BP level in the study group and insignificant difference in systolic and diastolic BP levels in the control group. SD: Standard deviation, BP: Blood pressure

scientific references, diastolic BP showed no change after doing exercises.^[15]

The study finding is consistent with that of Mohebi *et al.* who conducted a study on the effect of four sessions of resistance exercise on BP and reported a significant reduction in systolic BP, but not in diastolic BP.^[16] The results obtained by Berent *et al.* in a study on the relative advantages of resistance exercises in combination with resistance and aerobic exercises in cardiac patients are in line with the present study.^[17] The results of another study conducted by Castaneda *et al.* on the effect of resistance exercises in improving the glycemic control among the elderly with type 2 diabetes are consistent with the present study.^[18]

Contrary to our obtained results, Collier *et al.* reported a significant reduction in systolic and diastolic BP levels after 4 weeks of resistance exercise in women and men with pre-hypertension and stage 1 hypertension in the study group (*P* < 0.05). In the present study, similar to that of Collier *et al.*, there was a significant reduction in systolic BP too, and in both groups of pre-hypertension and stage 1 hypertension, mean length of intervention time was 45 min with at least 10 repetitions; but in their study, there was also a significant reduction in diastolic BP. As hypertension increases by age,^[2] one of the reasons for the above-mentioned difference can be higher age range in our study (57.5 ± 8.45) compared to that in Collier *et al.*'s study (47 ± 2). The number of exercise sets was initially one in our study, and then it was increased to three at the end of intervention, while in Collier *et al.*'s study, it was initially fixed at three, as a higher number of the sets yields better results.^[19] In our study, the subjects performed exercise as two sessions in a week, but in Collier *et al.*'s study, it was three sessions in a week. Results of Vona *et al.*'s^[20] study on 4 weeks of exercise in MI patients were not in line with our obtained results, and they reported no significant difference in systolic and diastolic BP levels (*P* > 0.01). In our study, in addition to cases of acute MI, there were subjects undergoing coronary bypass surgery, but in Vona *et al.*'s study, the subjects were only MI patients. In addition, the time interval between MI and start of rehabilitation was

3 weeks in Vona's study and at least 2 months in our study. The early start of rehabilitation may have prevented its positive effects on hypertension. The intervention time was 8 weeks in the present study and 4 weeks in Vona's study.

Longer intervention time may have yielded better results.^[21] In the study of Heffernan *et al.* on the effect of resistance exercise on central of BP among young men, no changes were reported in systolic and diastolic BP levels. In our study, we studied no specific race and the study was conducted on both men and women, but Heffernan studied just men from African American race who actually have a higher level and incidence of hypertension.^[2] The number of exercises was eight in our study and five in Heffernan's. A higher number of exercises leads to more positive results. The difference in resistance exercise method in the present study and Heffernan's study could have played a role in this case. In the present study, the exercise was conducted from upper limbs to lower limbs in each session in such a way that there was a combination in one session, but Heffernan conducted resistance exercises of upper limbs in 1 day and of lower limbs on the other day.^[14] The results obtained by Cauza *et al.* in a study on the relative positive effects of resistance and aerobic exercises on metabolic factors and muscular function are not in line with the present study.^[22] In the present study, the intervention was composed of two sessions a week for 8 weeks, and the exercises started as one set and were gradually increased to three sets at the end of intervention, while in Cauza's study, it was three sessions a week and lasted for 16 weeks, and also, it started with three sets and was increased to six sets. Another reason for the different results obtained can be the difference in BP measurement method. In the present study, BP was measured from both hands before and after intervention, and then, the mean of the measurements was calculated, while in Cauza's study, BP was measured during 5 days of the first and the last weeks of the study twice a day and the mean was calculated.

CONCLUSION

Our obtained results showed that doing resistance exercise for eight straight weeks led to a reduction in systolic BP

among the subjects with pre-hypertension and stage 1 hypertension, but it had no effect on diastolic BP. As this study was the first to investigate the effect of resistance exercise on pre-hypertension and stage 1 hypertension patients, conducting another clinical trial with a longer time, more intensity, and higher number of subjects is suggested. Due to the positive effect of intervention observed on the mean systolic BP in the present study, health care strategy makers can include this type of exercise in the rehabilitation programs. The authorities can allocate places inside the wards or hospitals for patients' rehabilitation where CCU nurses and cardiologists and other health team members could rehabilitate and educate these patients during their hospitalization and encourage them to do the exercises at home after discharge from hospital, so that patients can benefit from the advantages of these exercises parallel to medicational treatments.

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