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Effects of aerobic versus resistance training on blood pressure in hypertensive patients

Abstract

Study Design: Experimental study design.

Background: Aerobic training and resistance training are the two treatment technique used in reducing systolic blood pressure, diastolic blood pressure and heart rate. There is limited evidence for comparison of aerobic training and resistance training in reducing systolic blood pressure, diastolic blood pressure and heart rate.

Purpose of study: To establish the effect of aerobic training and resistance training on blood pressure in hypertensive patients.

Method: Total numbers of thirty patients were randomly assigned to receive either aerobic training or resistance training. Systolic blood pressure, diastolic blood pressure and heart rate were taken at baseline, 3rd week and 6th week in both the groups.

Result: In both the group significant improvement occurred in aerobic training and resistance training. Between groups analysis there was significant improvement in aerobic training when compared with resistance training.

Conclusion: Both aerobic and resistance training were found to be effective in reducing systolic blood pressure, diastolic blood pressure and heart rate. But aerobic training is more effective in reducing systolic blood pressure, diastolic blood pressure and heart rate when compared with resistance training.

Keywords: systolic blood pressure, diastolic blood pressure, heart rate

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Introduction

High blood pressure is one of the nine leading risk factors influencing the global burden of cardiovascular disease.[1] It is estimated to lead to seven million deaths each year that is about 13% of the total death worldwide.[2] Hypertension (systolic and diastolic blood pressure>140/90mmHg) is a major modifiable risk factor for cardiovascular disease. Elevated blood pressure levels have been shown to be a risk factor for stroke, congestive heart failure, myocardial infarction, peripheral vascular disease and end-stage renal disease.[3] Primary (or essential) hypertension is when the cause is unknown. The majority of hypertension cases are primary. It accounts for about 95% of cases. When there is an underlying problem such as kidney disease or hormonal disorders that can cause hypertension, it is called secondary hypertension.[4]

Regular physical exercise has been recommended for the prevention and treatment of hypertension.[5] Lowering of blood pressure and prevention of hypertension is in first instance preferable by lifestyle changes. These include weight loss, moderation of alcohol intake, a diet with increased fresh fruit and vegetables, reduced saturated fat, reduced salt intake and increased physical activity.[6] The effects of exercise on clinical blood pressure might be different in normotensive and hypertensive subjects. The effects of aerobic and resistance exercise on clinical blood pressure might be different, because they have different mechanical characteristics. Aerobic training is characterized by the execution of cycling, carried out with large muscle groups contracting at mild to moderate intensities for a long period of time. On the other hand, resistance training (also called weight or strength training) is characterized by the execution of exercises in which muscles from a specific body segment are contracted against a force that opposes the movement.[7]

Both aerobic endurance exercise and resistance training can promote substantial benefits in physical fitness and health related factors in older individuals.[8] Aerobic endurance training has a greater impact on maximum oxygen uptake (VO2 max) and associated cardiopulmonary variables and it more effectively modifies cardiovascular disease risk factors associated with the development of coronary artery disease. On the other hand regular resistance training offers the greatest potential for developing muscular strength, endurance and mass.[9]

Method

Design

Experimental study design was carried out with a sample of 30 participants. Participants were randomly allocated using sealed envelope method to receive either aerobic training or resistance training. Informed consent was taken from all the participants included in the study.

Subjects

The sample size was includes 30 subjects. Subjects were randomly divided into two groups. Group A having 15 subjects and Group B having 15 subjects. Inclusion criteria- Age<65 years, both male and female, Essential hypertension- Stage 1& Stage2, Hypertension - Systolic blood pressure 140-179mmHg and diastolic blood pressure 90-109mmHg. Exclusion criteria- Patient with secondary hypertension, Left ventricular hypertrophy, recent myocardial infarction, three or more risk factors of CVD, Patients using more than one hypertensive drug.[4]

Intervention

Group A was given aerobic training and Group B was given

resistance training. Group A Stretching and low intensity exercises of 10 minutes were given in each training session as warm-up prior to training. The aerobic training was given for three alternate days in a week at 60-70% of maximum heart rate for 6 weeks, up to the exhaustion level of the subjects. Omron Digital sphygmomanometer was used to measure heart rate during the aerobic exercise.[10] Heart rate, systolic and diastolic blood pressure were measured before and after the exercise in the sitting position. Recovery heart rate was measured at third minute of post exercise session in the aerobic training program. After the training session, cool down was given for 5-10 minutes.

Maximum heart rate was calculated by using the formula:

HRmax = 220-age

Group B Resistance training program was given for alternate days for 6 weeks. In resistance training four sets and 10 repetitions were performed by the subjects, based on the Delorme and Watkins technique. It was started with 10 lifts with 50% of 10 RM, then 75% of 10 RM and progressed to 100% of 10 RM. Seven different types of exercises were abdominal curl ups, biceps curls, triceps extension, back extension, leg curls, side leg raises and knee extension.[11]

Outcome Measure

Systolic blood pressure, diastolic blood pressure and heart rate were measured by Omron digital sphygmomanometer.

Results

Analysis of data collected for systolic blood pressure, diastolic blood pressure and heart rate of 30 subjects was done by statistical analysis tests using SPSS and software version 16. The results were considered and statistically significant at $p<0.025$. The characteristics of the data were presented through tables and graphs. Mean and standard deviation of all the variables were calculated. Comparison between the groups for all the variables (SBP, DBP and HR) on baseline, 3rd week and 6th week was done using unpaired t test. Comparison of effect of treatment within the group on baseline, 3rd week and 6th week for all the variables was done using paired t test.

Changes in SBP score

The mean±SD of SBP score for patients in Group A on baseline, 3rd and 6th week was 155.87±8.55, 149.07±8.71 and 141.20±8.41 respectively (Table 1 and Graph 1). Within group analysis revealed that there was highly significant reduction in SBP score in Group A ($p<0.001$) (Table 1).

The mean±SD of SBP score for patients in Group B on baseline, 3rd and 6th week was 156.73±8.37, 153.67± 8.54 and 150.47±8.27 respectively (Table 1 and Graph 1). Within group analysis revealed that there was highly significant reduction in SBP score in Group B ($p < 0.001$) (Table 1).

Between Group analysis showed that a significantly reduction in SBP score was observed in Group A at the end of 6th week as compared to that in Group B ($p\leq0.025$) (Table 2 and Graph 1).

Changes in DBP score

The mean±SD of DBP score for patients in Group A on baseline, 3rd and 6th week was 94.73±3.63, 91.13±3.39 and 85.20±3.78 respectively (Table 3 and Graph 2). Within group analysis revealed that there was highly significant reduction in DBP score in Group A ($p<0.001$) (Table 3). The mean±SD of DBP score for patients in Group B on baseline, 3rd and 6th week was 94.93±3.67, 93.00±3.66 and 88.46±3.29 respectively (Table 3 and Graph 2). Within group analysis revealed that there was highly significant reduction in DBP score in Group B ($p<0.001$) (Table 3). Between Group analysis showed that a significantly reduction in DBP score was observed in Group A at the end of 6th week as compared to that in Group B ($p\leq0.025$) (Table 4 and Graph 2).

Table 1 Changes of SBP within Group A and Group B.

Groups	Weeks	Mean ± SD	t- value	p- value
Group A	0 week	155.87±8.55	19.17	0.001**
	3 week	149.07±8.71		
	3 week	149.07±8.71	24.45	0.001**
	6 week	141.20±8.41		
	0 week	155.87±8.55	25.9	0.001**
	6 week	141.20±8.41		
Group B	0 week	156.73±8.37	12.35	0.001**
	3 week	153.67±8.54		
	3 week	153.67±8.54	12.22	0.001**
	6 week	150.47±8.27		
	0 week	156.73±8.37	14.19	0.001**
	6 week	150.47±8.27		

*Significant at $p\leq0.025$

**Highly significant at $p\leq0.001$

NS: Non significant

Table 2 Comparison of SBP between Group A and Group B.

Weeks	Group A	Group B	t- value	p- value
	Mean ± SD	Mean±SD		
0	155.87±8.55	156.73±8.37	0.28	0.78NS
3	149.07±8.71	153.67±8.54	1.45	0.15NS
6	141.20 ±8.41	150.47±8.27	3.03	0.005*

*Significant at $p\leq0.025$

**Highly significant at $p\leq0.001$

NS: Non significant

Table 3 Changes of DBP within Group A and Group B.

Groups	Weeks	Mean±SD	t- value	p- value
Group A	0 week	94.73±3.63	7.72	0.001**
	3 week	91.13±3.39		
	3 week	91.13±3.39	11.39	0.001**
	6 week	85.20±3.78		
	0 week	94.73±3.63	13.69	0.001**
	6 week	85.20±3.78		
Group B	0 week	94.93±3.67	3.65	0.003*
	3 week	93.00±3.66		
	3 week	93.00±3.66	6.71	0.001**
	6 week	88.46±3.29		
	0 week	94.93±3.67	9.78	0.001**
	6 week	88.46±3.29		

*Significant at $p\leq0.025$

**Highly significant at $p\leq0.001$

NS: Non significant

Changes in HR score

The mean±SD of HR score for patients in Group A on baseline, 3rd and 6th week was 85.26±6.32, 83.20±5.89 and 77.93±4.74

respectively (Table 5 and Graph 3). Within group analysis revealed that there was highly significant reduction in HR score in Group A ($p<0.001$) (Table 5). The mean±SD of HR score for patients in Group B on baseline, 3rd and 6th week was 87.06±7.11, 85.60±6.64 and 82.13±4.98 respectively (Table 5 and Graph 3). Within group analysis revealed that there was highly significant reduction in HR score in Group B ($p <0.001$) (Table 5). Between Group analysis showed that a significantly reduction in HR score was observed in Group A at the end of 6th week as compared to that in Group B ($p\leq 0.025$) (Table 6 and Graph 3).

Table 4 Comparison of DBP between Group A and Group B.

Weeks	Group A Mean ± SD	Group B Mean±SD	t- value	p- value
0	94.73±3.63	94.93±3.67	0.14	0.88NS
3	91.13±3.39	93.00±3.66	1.44	0.15NS
6	85.20±3.78	88.46±3.29	2.52	0.017*

*Significant at p≤0.025

**Highly significant at p≤0.001

NS: Non significant

Table 5 Changes of HR within Group A and Group B.

Groups	Weeks	Mean ± SD	t- value	p- value
Group A	0 week	85.26±6.32	3.41	0.004*
	3 week	83.20±5.89		
	3 week	83.20±5.89	7.67	0.001**
	6 week	77.93±4.74		
	0 week	85.26±6.32	12.41	0.001**
	6 week	77.93±4.74		
Group B	0 week	87.06±7.11	2.7	0.017*
	3 week	85.60±6.64		
	3 week	85.60±6.64	6.5	0.001**
	6 week	82.13±4.98		
	0 week	87.06±7.11	6.61	0.001**
	6 week	82.13±4.98		

*Significant at p≤0.025

**Highly significant at p≤0.001

NS: Non significant

Table 6 Comparison of HR between Group A and Group B.

Weeks	Group A Mean ± SD	Group B Mean ± SD	t- value	p- value
0	85.26±6.32	87.06±7.11	0.73	0.47NS
3	83.20±5.89	85.60±6.64	1.04	0.30NS
6	77.93±4.74	82.13±4.98	2.36	0.025*

*Significant at p≤0.025

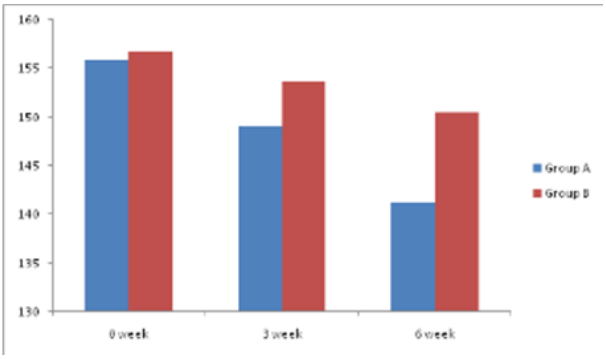
**Highly significant at p≤0.001

NS: Non significant

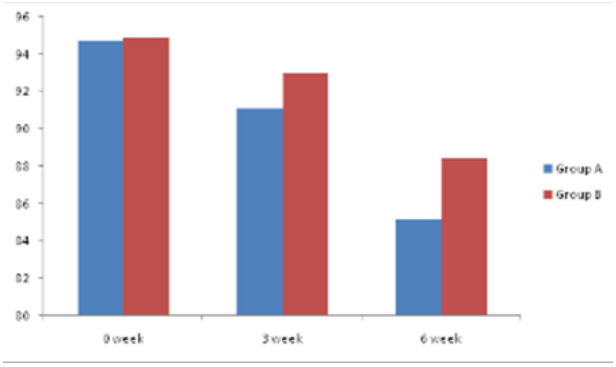
Discussion

The recent Joint National Committee on prevention, detection, evaluation and treatment of high blood pressure recommended that optimal blood pressure levels should be less than 120/80mmHg for resting systolic and diastolic blood pressure.[12] Physical activity is recommended as prevention, treatment and control of all stages of hypertension.

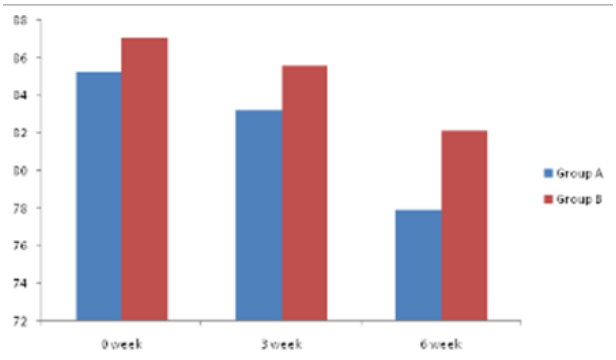
The management of high blood pressure is considered a priority objective in primary and secondary prevention of cardiovascular disease. An aerobic exercise is an increase in oxygen consumption and heart rate that parallels the intensity of the imposed activity and a curvilinear increase in stroke volume while resistance training offers greater development of muscular strength, endurance and mass. As many leisure and occupational tasks require static or dynamic efforts. So, the pressure response to resistance exercise is largely proportional to the percent of maximal voluntary contraction as well as the muscle mass involved. Increased muscle strength results in an attenuated heart rate and blood pressure response to any load because the load represents a lower percentage of maximal voluntary contraction.[13]



Graph 1 Changes of SBP in Group A and Group B.



Graph 2 Changes of DBP in Group A and Group B.



Graph 3 Changes of HR in Group A and Group B.

S R Collier et al.[12] found the effect of four weeks of aerobic and resistance exercise training on arterial stiffness, blood flow and blood pressure in pre-hypertension and stage 1 hypertensive found that resistance exercise resulted in increased arterial stiffness whereas aerobic exercise training decreased arterial stiffness in individuals with pre-hypertensive to essential hypertension despite similar reductions in blood pressure.[12]

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Jen Chen et al.[14] found the effect of regular endurance exercise training on blood pressure and quality of life in patients with hypertension and found that low to moderate intensity exercise is effective in lowering blood pressure. When compare the effect of different exercise intensities, low intensity exercise was more effective in lowering blood pressure than was high intensity exercise.[14]

The present study compared the effects of aerobic versus resistance training on blood pressure in hypertensive patients. Baseline blood pressure and heart rate was evaluated by Omron digital sphygmomanometer were found to be significantly increased in all the patients included in the study.

Results revealed that patients in Group A who received aerobic training for 6 weeks was statistically significant improvement in SBP by 4.36% and 9.41%, DBP by 3.8% and 10.06% and HR by 2.41% and 8.59%.

Sambhaji Gunjal et al.[4] found that the effect of aerobic interval training on blood pressure and myocardial function in hypertensive patients and showed significant reduction in blood pressure, improvement in cardiac function, aerobic capacity and reduction of mean heart rate.[4]

Meruna Bose et al.[15] found that the effect of short duration aerobic exercise on resting blood pressure and heart rate in pre-hypertensive and stage 1 hypertensive subjects and found that there was significant decrease in values of systolic blood pressure, diastolic blood pressure and heart rate after the 6 weeks of aerobic training in hypertensive individuals. The percentage change in the values were found to be more in men than women and changes was more marked in individuals below 50 years of age than individuals above 50 years of age. This is due to aging changes in the cardiovascular system which is irreversible. The arteries of the heart become thicker, stiffer and less flexible.[15]

Similarly, patients in Group B received resistance training also showed a statistically improvement in SBP by 1.95% and 3.99%, DBP by 2.03% and 6.81% and HR by 1.67% and 5.66%.

Fabio T Montrezol et al.[16] concluded that the resistance training promotes a reduction in blood pressure and an improvement in muscle strength. Resistance training increased circulating levels of adiponectin and reduced the levels of plasma Intracellular Adhesion Molecule-1. Due to augmentation in catecholamines during resistance training, especially epinephrine. A redistribution of adhesion molecules in the endothelium occur, since neutrophils and lymphocytes have receptors to catecholamines. And catecholamine elicits expression of specific adhesion molecules and changes in its cytoskeletal organizations then altering its adhesion to endothelial wall. There was improvements in muscle strength in training group ($p<0.01$) and significant reduction in the systolic blood pressure during the day time in training group was ($p<0.05$).[16]

J. del Pozo – Cruz et al.[17] found the hypotensive acute effect of a combined resistance and walk based exercise among over 65 year old community dwelling women and found that a single bout of combined resistance and walking based exercise is feasible, safe and effective significantly decreasing the diastolic blood pressure in both post exercise 9% and after post 24 hour post exercise 7%. The decrease in the diastolic blood pressure seems modest. It has been shown that a decrease in blood pressure of at least 2mmHg is associated with 6% decrease in mortality from stroke and 4% from coronary heart disease.[17]

Antonio Paoli et al.[8] found the effects of high intensity circuit training, low intensity circuit training and endurance training on blood pressure and lipoproteins in middle aged overweight men and the main finding of this study was the greater effect on blood lipids improvement of a high intensity circuit compared to a lighter circuit or to an endurance training. Different kinds of circuit showed different effects on blood pressure. Low intensity circuit training more improves systolic blood pressure compared to high intensity training and endurance training while the effect of exercise on diastolic blood pressure was greater in response to high intensity circuit training. Resistance training has long been accepted for developing and maintaining muscular strength, endurance, and power and muscle mass.[8]

In summary, the result of our study revealed that both treatment techniques were effective in reducing systolic blood pressure, diastolic blood pressure and heart rate but statically there was significant difference between both the groups at the end of 6th week. So, the result lead us to reject the null hypothesis thereby confirming that there will be significant difference between effectiveness of aerobic and resistance training in reducing blood pressure in hypertensive patients.

Limitation of study

1. Sample size was small.
2. Study duration was short.
3. Follow-up of aerobic and resistance training was not done.

Relevance to Clinical Practice

The finding of the present study suggests that aerobic and resistance training in patients of hypertension leads to decrease in blood pressure. Aerobic exercise is easily done on the ground level by the patients as aerobic exercise was not done effectively on treadmill or cycling by the patients of all age. The encouraging effect of aerobic and resistance training in our study suggests that both the training have useful adjunctive intervention in the management of blood pressure in patients with hypertension.

Future Research

The present study investigated the effect of aerobic versus resistance training on blood pressure in hypertensive subjects. So, future research with larger study population may evaluate the impact of aerobic and resistance training on arterial stiffness due to high blood pressure. For future research arterial stiffness should be measured by pulse wave velocity. These finding will be able to clearly demonstrate the mechanism of improvement in blood pressure when using aerobic and resistance training.

Conclusion

Results of the study showed that in patients with aerobic and resistance training yielded a clinically significant improvement in hypertension. On between Group A and Group B analysis there is significant improvement in aerobic training when compared with resistance training at the end of 6th week. So, the result of the study indicated that aerobic training performed on ground can also bring significant improvement in patients with hypertension.

Conflicts of Interest

The authors do not have any Conflict of interests.

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