Effect of Different Types of Training on Left Ventricular Structural and Functional Characteristics of Untrained Man Students

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Abstract: The purpose of the study was to determine the effect of eight weeks program period endurance, resistance and concurrent training on left ventricular structural (left ventricular mass, end diastolic diameter, posterior wall thickness and interventricular septum thickness) and functional characteristics (ratio of E/A, stroke volume and ejection fraction) of untrained men students. Thirty-six untrained students with mean of age 21±2 years, participate in the study. Before and after of training, the effect of independent variables on dependent variables were measured. The t-test and one-way ANOVA analysis of variance were used. To determine within and between groups different, one-way ANOVA (post-hoc Tukey) test was used to show the significant changes in each variables (p<0.05). The study showed that after endurance training, the ratio of E/A, ejection fraction, stroke volume and interventricular septum thickness were increased (p<0.05). End diastolic diameter, posterior wall thickness, interventricular septum thickness, left ventricular mass, ratio of E/A and stroke volume were significantly changed after resistance training (p<0.05). Posterior wall thickness, interventricular septum thickness, left ventricular mass, stroke volume and ejection fractions were also increased after concurrent training. There were significant differences due to the effect of different mode of trainings on structural and functional characteristics of the participants.

Key words: Left ventricle mass • Left ventricular end diastolic diameter • Posterior wall thickness • Ratio of E/A • Stroke volume • Ejection fraction

INTRODUCTION

Exercise training has been reported to influence left ventricular structure with equivocal data reported regarding resting left ventricular function. However, the majority of studies have focused on the effect of endurance, resistance and concurrent training on left ventricular structure and function. Exercise training lasting several weeks increases heart size and improves cardiac reserve capacity manifested as increases in cardiac output and stroke volume during maximal exercise [1-4]. This adaptive increase in pump performance of the heart contributes to the increase in maximal O2 uptake (V O2 max) in the trained state [5-8]. The increase in stroke volume in response to training is mediated by increases in left ventricular end-diastolic volume and diastolic filling [1-2, 9-10] which may likely be associated with a greater plasma volume [11-12].

Although these adaptations occur with exercise training lasting several weeks, it is not known whether endurance, resistance and concurrent training (eight weeks of training) can elicit comparable improvements. Similar to endurance, resistance and concurrent training, induces a significant increase in structural and functional characteristics at rest [2, 5, 13-15].

Some of the studies showed that short middle and long period of power training cannot have relationship with left ventricular wall thickness, left ventricular end diastolic diameter and left ventricular mass changes but others studies showed that resistance training causes increased left ventricular wall thickness [2, 15-18].

Some of the studies show meaningful increase in left ventricular mass and wall thickness [1-3, 5] but some other studies don’t show meaningful difference in trained resistance group in comparison to control group [2, 9, 18]. Studies showed that posterior and membranous of left

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ventricular wall thickness of men control group is either less than resistance group or doesn’t have any difference with them [15-17, 19] and the thickness of posterior and membranous in trained endurance individuals is more than trained resistance ones [20]. Some studies have not reported any difference between left ventricular walls thickness in resistance and endurance trained samples and also left ventricular end diastolic diameter in control group was than resistance trained individuals [15, 18-19], with considering this issue that endurance, resistance and concurrent training are accounted as common axes of all exercises. Therefore, studying on the effect of everyone in independent or compound of them has great importance. In this research there is a question that if eight weeks of resistance, endurance and concurrent training can have significance changes in function and structure of left ventricular muscle, heart and vascular system in men athletes university students. Can eight weeks training have significance changes in stroke volume, ejection fraction, end diastolic diameter, ratio of early and ventricular filling velocities (E/A) and ratio of left ventricular wall thickness to body weight and surface in men athletes heart and how are these changes? In this study with considering of taken changes on left ventricle in endurance, resistant and concurrent training can anticipate athlete heart adaptations.

MATERIALS AND METHODS

Statistical population of this research contains untrained students in Islamic Azad University, Chalous Branch. The study participants were 36 men untrained students (age 21.03 ± 1.2 years). Twelve of Samples selection in each group randomly.

<table>
<thead>
<tr>
<th>Sample selection phases</th>
<th>Number of samples</th>
<th>Percent of assembly frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>The samples who had necessary conditions from aspect of common health and not doing regular physical training</td>
<td>80</td>
<td>100%</td>
</tr>
<tr>
<td>The sample were selected randomly between volunteers</td>
<td>40</td>
<td>50%</td>
</tr>
<tr>
<td>Confidence of non risk performing exercise training, with examination of confidant and specialist doctor</td>
<td>36</td>
<td>45%</td>
</tr>
<tr>
<td>Samples selection in each group randomly</td>
<td>12</td>
<td>15%</td>
</tr>
</tbody>
</table>

Present research is quasi-experimental research. For selection statistics sample recalled interesting individual for participate in the research. To investigate the effects of training on left ventricular structural and functional characteristics, subjects were evaluated both before and following endurance, resistance and concurrent training at rest and during 75 min/day and at three day per week. Endurance training was performed for interval running. The training period of training ranges %60-80 heart rate reserve and were run for two minutes. The rest period, as running slow and ranges %35-45 heart rate reserve and were running about a minute. Resistance training program included circuit resistance training and combined training program includes a combination of endurance and resistance training.

All exercise training was performed in an environmentally controlled, with temperature and humidity maintained between 22 and 24°C and <%50, respectively. No subject smoked, used recreational drugs, or had significant chronic medical problems. Subjects were screened with a history and physical examination that including echocardiogram. Two-dimensionally guided transthoracic M-mode echocardiograms were obtained at rest to quantify left ventricular mass, end diastolic diameter, posterior wall thickness, interventricular septum thickness, ratio of E/A, stroke volume and ejection fraction. Descriptive and inferential statistics were used for data analysis and description. Kolmogorov-Smirnov test was used for examination of normal data distribution and Levin test used for examination of hypothesis equality on intergroup variance. Student’s t-test was used to test for differences in resting left ventricular structural and functional characteristics before and following training. All comparisons were based on a %95 confidence limit (probability level p<0.05). One-way ANOVA analysis of variance was used for comparison of significance between echocardiography selective factors in endurance, resistance and concurrent groups. If variance analysis difference is showed, One-way ANOVA (post-hock Tukey) test is used for analysis and comparison of three group’s variables.

RESULTS

Research finding has shown that endurance training causes significance increased in weight, body surface, free fat mass, body mass index, resting heart rate, maximal aerobic power and reduced diastolic blood pressure (p=0.05). Resistance training causes significance increased in weight, body surface, fat mass body mass index and whole body power and also concurrent training cause’s significance increased in weight, fat mass, body mass index, maximal aerobic power and whole body power (p=0.05).
The results of examination of left ventricular functional and structural characteristics on the basis of three groups’ absolute and relative values are as follow:

**Comparison of Left Ventricular End Diastolic Diameter Mean (mm) in End Diastole:** With considering of left ventricular end diastolic diameter means, present and post test difference means are meaningful in resistance and concurrent groups (p=0.005, p= 0.047) therefore null hypothesis is rejected with %95 of confidence and therefore resistance and concurrent training causes increased left ventricular end diastolic diameter (Figure 1).

**Comparison of Left Ventricular Posterior Wall Thickness (mm) Mean in End Diastole:** With considering of left ventricular wall thickness minus in three testing groups, means difference of pretest and posttest of resistance and concurrent group is meaningful (p=0.004, p=0.20). Therefore null hypothesis with %95 confidence is rejected and therefore resistance and concurrent training causes increased left ventricular wall thickness (Figure 2).

**Comparison of Interventricular Septum Thickness (mm) in End Diastole:** With considering of means minus of left ventricle interventricular septum thickness in three groups, means difference of pretest and posttest of endurance, resistance and concurrent groups are meaningful (p=0.008, p=0.01, p=0.05). Therefore null hypothesis with %95 is rejected and therefore endurance, resistance and concurrent training causes increased left ventricle interventricular septum thickness (Figure 3).

**Comparison of Left Ventricle Mass (g) Mean:** With considering of left ventricle mass means minus in three groups, pretest and posttest means difference in resistance and concurrent groups are meaningful (p=0.0004, p=0.03). Therefore null hypothesis with %95 is rejected and therefore resistance and concurrent training causes increased left ventricle mass (Figure 4).

**Comparison of Ratio of Peak Velocity During Early and Late Diastole (m/s):** With considering of means minus, ratio of initial flow velocity peak of mitral in three groups, means difference of pretest and posttest of endurance and resistance groups is meaningful (p=0.002, p=0.004). Therefore null hypothesis with %95 confidence is rejected and therefore endurance and resistance training causes increased initial flow velocity peak ratio of mitral to delay flow velocity peak of mitral (Figure 5).

**Comparisons of Stroke Volume Mean (ml):** With considering of stroke volume means minus in three groups, means difference in pretest and posttest of endurance, resistance and concurrent groups is meaningful (p=0.02, p=0.02). Therefore null hypothesis of %95 confidence is rejected and therefore, endurance, resistance and concurrent training cause increased stroke volume (Figure 6).

![Fig. 1: Comparison of left ventricular end diastolic diameter mean (mm) in end diastole before and after performing training program](image1)

![Fig. 2: Comparison of left ventricular postriror wall thickness (mm) before and after performing training program](image2)
Fig. 3: Comparison of interventricular septum thickness (mm) means, before and after performing training

Fig. 4: Comparison of left ventricle mass means (g), before and after performing training program

Fig. 5: Comparison of means ratio of peak velocity during early and late diastole (m/s), before and after performing training program

Fig. 6: Comparison of stroke volume means (ml) before and after performing training program

Fig. 7: Comparison of left ventricle ejection fraction (percent) size means before and after performing training program
Comparison of Mean of Left Ventricle Ejection Fraction (Percent) Size: With considering of ejection fraction means minus in three groups, means difference of pretest and posttest of endurance and concurrent group is meaningful (p=0.03, p=0.02). Therefore null hypothesis with %695 confidence is rejected and therefore, endurance and compound training cause increased ejection fraction (Figure 7).

Comparison of Mean of Left Ventricle End Diastole Diameter Between Groups: As the result have shown, none of the training programs have degree mean higher than two other groups. Kruskal-wallis chi square is equal 3.18 that isn’t significance (p=0.20). Therefore null hypothesis is accepted and we conclude that there isn’t significant difference between left ventricle end diastolic diameter means in endurance, resistance and concurrent groups (Table 1).

Comparison of Left Ventricle Wall Thickness Mean Between Testing Groups: As the result have shown, none of training program have degree mean higher than two other groups. Kruskal-wallis chi square is equal 3.85 that isn’t meaningful (p=0.15). We conclude that there isn’t significance difference between mean of left ventricle wall in endurance, resistance and concurrent groups (Table 2).

Comparison of Mean of Left Ventricle Intervertricular Wall Thickness Between Testing Groups: Comparison of mean of between testing groups showed that F of table of freedom degree of 2 and 33 in 0.05 and 0.01 levels is 3.29 and 5.33. Since accounted F (5.84) is bigger than table’s F, the meaningful level (0.07) is not accepted. Therefore null hypothesis is rejected and we conclude that there is significance difference between E:A ratio mean in endurance, resistance and concurrent groups (Table 5) one-way ANOVA (post-hock Tukey) test is used for recognizing significance difference between means of each group and it is recognized that there is significance difference between endurance and resistance groups (Table 4).

Comparison of Left Ventricle Mass Mean in Testing Groups: Comparison of mean of between testing groups showed that F of table with freedom degree of 2, 33 in 0.05 and 0.01 levels is 3.29 and 5.33. Since account F (3.94) is bigger table’s F in 0.05 level, therefore null hypothesis is rejected and we result that there is significance difference between left ventricle mass mean in endurance, resistance and concurrent groups (Table 4) one-way ANOVA (post-hock Tukey) test is used for recognizing significance difference between means of each group and it is recognized that there is significance difference between endurance and resistance groups (Table 4).

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Table 1: Comparison of left ventricle end diastolic diameter mean between groups

<table>
<thead>
<tr>
<th>Training program</th>
<th>Mean</th>
<th>df</th>
<th>Chi square</th>
<th>Meaningful in Kruskal-wallis test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endurance</td>
<td>14.68</td>
<td>2</td>
<td>3.18</td>
<td>0.204</td>
</tr>
<tr>
<td>Resistance</td>
<td>22.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concurrent</td>
<td>18.50</td>
<td></td>
<td></td>
<td></td>
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</table>

Table 2: Comparison of left ventricle wall thickness mean between testing groups

<table>
<thead>
<tr>
<th>Training program</th>
<th>Mean</th>
<th>df</th>
<th>Chi square</th>
<th>Meaningful in Kruskal-wallis test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endurance</td>
<td>13.96</td>
<td>2</td>
<td>3.85</td>
<td>0.15</td>
</tr>
<tr>
<td>Resistance</td>
<td>19.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concurrent</td>
<td>22.25</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Table 3: Comparison of mean of left ventricle intervertricular wall thickness between testing groups

<table>
<thead>
<tr>
<th>Changes references</th>
<th>Sum of squares</th>
<th>df</th>
<th>Squares mean</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endurance</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1.15</td>
<td>0.33</td>
</tr>
<tr>
<td>Resistance</td>
<td>28.8</td>
<td>33</td>
<td>0.873</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concurrent</td>
<td>30.8</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
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</table>
Comparison of Left Ventricle Stroke Volume Mean in Testing Groups: Comparison of mean of between testing groups showed that F of table with freedom degree of 2 and 33 in 0.05 and 0.01 levels is 3.29 and 5.33. Since accounted F (0.272) is smaller than table’s F, significance level (0.76) is not accepted. Therefore null hypothesis is accepted. We conclude that there isn’t significance difference between stroke volumes means in endurance, resistance concurrent groups (Table 6).

Comparison of Left Ventricle Ejection Fraction Mean Between Testing Groups: As the results show, none of the training programs has higher degree mean in ratio to other two groups. Kruskal-Wallis chi square is equal 2 that is not significance (p=0.37). We conclude that there isn’t significance difference between means of left ventricle ejection fraction in endurance, resistance concurrent groups (Table 7).

DISCUSSION

These data indicate that eight weeks of endurance, resistance and concurrent training elicits rapid adaptation to the left ventricular functional response exercise, with increases in stroke volume being secondary to a Frank-Starling effect with minor changes in contractile performance. This produced a volume-induced bradycardia and increase in left ventricular filling in endurance training. Changes in left ventricular systolic performance have contributed to the rise in stroke volume in the present study [18, 21-22].

It is well known that endurance training has been associated with increased left ventricular chamber volume [2, 4-5, 8], with small changes in wall thickness [7-8, 16]. In addition, chronic training increases the capacity to utilize the Frank-Starling relation without a change in blood volume [1, 4, 9], possibly by increasing LV compliance [1, 20-21]. This would enhance ventricular volume at a given filling pressure and may explain how SV could be increased following training. The findings were associated with an increase in VO2max. These observations are consistent with prior reports of improved aerobic power and cardiodynamic responses to exercise after periods of training [6, 14, 17, 22] Increases in left ventricular ejection fraction means were detected at the highest exercise intensities. Of particular interest was the finding of an elevated cardiac output at the same high exercise intensity level following endurance and concurrent training [1, 12-13, 20].
Measuring of end diastolic diameter in endurance trained samples was shown that in 0.25 of them changed this diameter more than six millimeters. Of course, left ventricle end diastolic diameter changes in resistance group were more and in endurance group were less than other groups. This research has shown that resistance and concurrent training significance increased left ventricle end diastole diameter which likely is because of interval and circular training. Last studies have shown that in endurance training because of increasing of plasma volume and Frank starling’s rule, left ventricle end diastolic volume increases [3, 9, 13-14, 19] but in this study, eight weeks of interval running cause decreased left ventricle end diastolic diameter that although end diastolic volume is increased in these samples, this decreasing likely, was from increasing in other left ventricle axes. Along with eight weeks of training program, resistance training caused increase in left ventricle walls thickness and end diastolic diameter. In resistance and concurrent training, because of over load pressure, wall thickness and interventricular thickness were increased. These training can cause increase in maximal heart rate along training periods. Although the mean of arterial blood pressure was increased and compound of overload pressure a volume were increased, wall’s thickness was increased significantly [15, 17-18, 20]. Also in this study, eight weeks training with using of both characteristics of overload pressure and volume cause middle changes in wall’s thickness and left ventricle end diastolic diameter. With considering of walls’ thickness changes and end diastolic diameter, left ventricle changes in resistance group were more and in endurance group were less than other groups. Research findings in three types of endurance, resistance and concurrent groups have shown that after eight weeks of noted physical training, ratio of E/A was increased 0.36, 0.19 and 0.9 centimeter. With decreasing of the number of heart rate and left atrium function in falling vertical and becoming longer of diastole phase, amount of A decrease and as a result ratio E/A increase [15, 20] that these changes in two groups of endurance and resistance were significance. Stroke volume changes also are created because of increasing of end diastolic volume and decreasing of volume in end systolic, in concurrent group was seen more and in resistance group was less than other groups. In this study, concurrent training caused increase in maximal heart rate along training periods. Although both amounts of overload pressure and volume were compounded, stroke volume and as a result ejection fraction increased significantly.

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REFERENCE


