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The Effect of Aerobic Training with and without Elastic Pressure on Complete Blood Count in Obese Males with Deep Vein Thrombosis

Seyyed Majid Hasanzadeh Fard[1], Nasser Behpour[2*], Mehdi Roozbahani[3]

[1]PhD. Student in Exercise Physiology, Department of Physical Education and Sport Science, Borujerd Branch, Islamic Azad University, Borujerd, Iran.
[2]Associate Professor of Exercise Physiology, Faculty of Sports Sciences, Razi University, Kermanshah, Iran.
[3]Assistant Professor, Department of Motor Behavior, Borujerd Branch, Islamic Azad University, Borujerd, Iran.

Abstract

Objective: Standard compression stockings are used to create elastic pressure in correcting and maintaining the hemodynamics of deep vein thrombosis (DVT) and prevent limb swelling in patients with DVT. This study aimed to compare the effect of aerobic exercise with lower extremity elastic pressure on some hematological features of obese patients with DVT.

Materials and Methods: For this purpose, 33 obese men (30≤BMI≤36) with DVT were randomly divided into three groups: 1) aerobic exercise with elastic pressure, 2) aerobic exercise without elastic pressure, 3) control group. Interventions were performed for 8 weeks of running in 55-70% of heart rate reserve. To create elastic pressure, elastic socks were used during exercise. Fasting blood samples were taken before and 48 hours after the last training session to compare red blood cells (RBC), hemoglobin, hematocrit, platelets, and white blood cells (WBC) between the groups. ANOVA statistical test and Bonferroni post hoc test were used to compare data.

Results: Although aerobic exercise alone did not lead to changes in variables ($P > 0.05$), aerobic exercise with elastic pressure reduced RBC (*P:* 0.001), hemoglobin (*P*: 0.001), hematocrit (*P*: 0.001) and platelets (*P*: 0.001). But changes in WBC were not significant (*P*: 0.192).

Conclusion: Aerobic exercises with elastic pressure on the lower limb muscles play an important role in re-balancing homeostasis. The erythrocyte systems changes of peripheral blood and reducing hematological factors and reduces hematological parameters in people with DVT are the main factor.

Keywords: Aerobic exercise, Elastic pressure, Deep vein thrombosis, Hematological parameters

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Corresponding Author:
Nasser Behpour, Associate Professor of Exercise Physiology, Faculty of Sports Sciences, Razi University, Kermanshah, Iran.
Tel: (98) 912 327 1873
Email: n_behpoor@yahoo.com
Orcid ID: 0000-0003-4987-9872

Introduction

Obesity has been introduced not only as a risk factor for hypoventilation syndrome, but also as an important risk factor for deep vein thrombosis (CVT) (1). DVT is a common medical condition associated with severe and fatal disabling complications such as pulmonary embolism (2). The goal of DVT treatment in the acute phase is to reduce or eliminate the pain of swollen limbs, prevent clot spread and subsequent pulmonary embolism. Long-term goals of treatment include preventing recurrence and complications such as post-thrombotic syndrome (3).

Thrombosis is a multifactorial phenomenon and different factors may play a role in the formation of thrombosis. Changes in smooth muscle and connective tissue reduce the dilation and elasticity of the veins (4,5). Another factor that can interfere with the potential for oxygen delivery by the blood is the degree of viscosity or hardness of the blood, which is also determined by the percentage of hematocrit to plasma (6).

Epidemiological studies have shown a positive and significant relationship between increased hematocrit and venous thrombosis. Also, the highest risk of cardiovascular disease in people with CVD has been attributed to high hematocrit. A study in the UK found a 30% increase in ischemic heart disease in people with venous thrombosis and high hematocrit (7) and pointed to a direct link between high hemoglobin and venous thrombosis. Red blood cells may increase the anticoagulant activity of lipopolysaccharide-treated monocytes or contribute to thrombin production in deep vein thrombi (8). Based on the available evidence, the rate of hematological factors in people with venous thrombosis is high (7,8).

Physical activity is associated with changes in the peripheral blood erythrocyte system. Several previous studies have reported red blood cell changes possibly due to endurance training (9,10). Natale et al conducted a study on the effect of three different types of activities (resistance, severe aerobics and low intensity) on hematological variables. The results showed that intense aerobic activity causes more changes than the other two types of training (11). Mousavizadeh et al also reported that eight weeks of aerobic exercise reduced erythrocytes (12). In addition, changes in body posture that occur during exercise lead to rapid accumulation of blood in the lower extremities and alterations in plasma to surrounding tissues (13). Because hematological markers cause many physiological changes in the body, it is possible that exercise, due to the effects of hematological markers can improve the diseases associated with these markers in people with DVT is effective (11,12).

Some other studies have pointed to a close relationship between obesity and DVT, especially in obese patients (14). This relationship supported by a direct genetic association between the obesity-specific locus FTO and DVT with PE, implies that obesity is most likely to be causally associated with DVT (15). On the other hand, based on some previous observations, a leg muscle compression is a treatment option in patients with chronic venous insufficiency (CVI) and people with DVT (16,17). This treatment is based on the fact that it is possible to help relieve pain symptoms and improve venous function in these people by inclined compression (18,19). A variety of compression devices such as elastic bandages, sloping compression stockings, anabots (boots) and elastic clothing are available for use by people. Of course, elastic bands and anabots are usually used only for short-term compression with dressings and have fewer places in long-term preventive treatment (20-22). On the other hand, no study has been done so far that the effect of aerobic training using elastic pressure on hematological parameters on obese people with DVT. Therefore, the present study aims to determine the effect of aerobic exercises combined with elastic and non-elastic pressure on leg muscles on hematological factors in obese men with DVT.

Materials and Methods

This study is a semi-experimental study. Subjects in this study include 33 middle-aged obese men (53 ± 2.82 years) with DVT in Kermanshah. In line with the research objectives, the subjects were randomly divided into 3 groups; 1) aerobic exercise with elastic pressure (n= 11), 2) aerobic exercise without elastic pressure (n= 11) and 3) control group (n= 11).

Inclusion criteria

The subjects are non-smokers and non-athletes and have not participated in regular exercise in the past six months. Inclusion criteria include confirmation of DVT by a physician, no history of diabetes, kidney disease and other chronic diseases. The implementation process and the exact details of the tests and research objectives were explained to the subjects, then the consent form was completed by them.

Exercise protocol

The exercise program lasted 8 weeks (3 sessions /weekly) in the form of running on a flat surface without a slope with exercise intensity of 55 – 70 % of HRR. Each workout session began with 5-10 minutes of warm-up and stretching, and ended with 5 minutes of cooling. Running time in the first week was 30 minutes in each session and gradually increased to 55 minutes by the last week. The exercise intensity was %55HRR in the first week and gradually reached %70 HRR insulin in the last week (Table 1). The exercise intensity was controlled using the Polar heart rate tester (made in the US). Subjects in the KAATSU-walk group wore pressure cuff belts (KAATSU Master, Sato Sports Plaza, Tokyo, Japan) on both legs during all walk training sessions. Systolic blood pressure was adjusted to limit blood flow in the 180 mm Hg range (23,24). Control subject did not participate in exercise program and were instructed to maintain their habitual activities.

Biochemical analysis

Fasting blood samples were taken 24 hours before exercise and 48 hours after lasting exercise session to evaluate biochemical variables. After resting for 10 minutes in a sitting position, the blood sample was taken from the brachial vein and poured into tubes containing EDTA (Diamine Tetra Acetic Acid Ethylene). An automatic counter was used to measure hematology indicators (Mindray - BC 5300 Auto Hematology Analyzer). Counting of WBC was done manually using a LEICA microscope (DM500; Germany).

Statistical methods

Statistical analysis was performed with the SPSS software version 22. Shapiro-Wilk test was used to ensure the normal distribution of data. ANOVA statistical test and Bonferroni post hoc test were used to compare the data. Paired T-test was used to determine the intra-group changes of variables in each group. A criterion alpha level of $P \leq 0.05$ was used for all statistical comparisons. P of less than 0.05 was regarded as indicative of a significant difference.

Ethical considerations

The ethics committee approved this study of Islamic Azad University, Boroujerd Branch, Iran (Ethic code: IR.IAU.B.REC.1400.010).

Results

Pre and post training body weight and BMI of 3 groups are shown in Table 2. Based on data by one way ANOVA, no significant differences were observed in body weight and

Table 1. Distribution and exercise time in aerobic training program

Weeks	1	2	3	4	5	6	7	8
Exercise intensity (%HRR)	55	55	60	60	65	65	70	70
Time (min)	30	30	35	35	40	40	45	45

BMI between 3 groups at baseline (*P*> 0.05). On the other hand, the results of intra-group changes by Paired sample T-test revealed a significant decrease in weight and BMI compared to the pre-test in aerobic and aerobic + elastic pressure groups (*P*< 0.05). There were no changes in these variables in the Control group (*P*> 0.05).

Based on the results of the ANCOVA test, a significant difference was observed in RBC (*P*: 0.001), Hemoglobin (*P*: 0.001), Hematocrit (*P*: 0.001) and Platelets (*P*: 0.001) between the studied groups. However, no significant difference in WBC (*P*: 0.76) was observed between the groups (Table 3).

On the other hand, the results of Bonferroni post hoc test revealed that the changes in each variables mentioned in table 4 are significant between both control and Aerobic + Elastic groups as well as between Aerobic and Aerobic + Elastic groups but not between Control and aerobic groups (Table 4).

Also, the intra -group changes of each of the variables based on the paired sample T-test are summarized in Table 5. Based on the findings, there was no significant difference between pre and post-training in each of the variables in control and aerobic groups (*P*> 0.05). In other words, in the aerobic group, aerobic training alone did not change any of the variables compare to pre-test (*P*> 0.05). However, in the aerobic + elastic group, except for WBC, significant difference was observed between the pre and post-training in other variables (*P*< 0.05).

Discussion

The main finding of the present study was a decrease in hematologic indices of red blood cells, hemoglobin, hematocrit and platelets in middle-aged men with DVT in response to 8 weeks of combined aerobic exercise using elastic pressure. The results of the present study were consistent with Evensen et al, Rajabi et al and Kishimoto et al in terms of the effect of elastic pressure training on the reduction of hematological factors (25-27) and with The results of research by Shahpourabadi et al, Ahmadizad et al, Pourqardash et al as well as Amini et al were inconsistent (9,13,28,29). Among the reasons for the inconsistency of the results of the present study with the mentioned researches, we can mention the fact that the population studied, the population of the study population, the type of the study population and the number of women. Hematology and edema factors have been reported to increase the risk of hemorrhage and edema. The results of studies have shown that regular aerobic exercise plays an important role in rebalancing homeostasis by reducing precoagulation factors and increasing anticoagulation factors (9,29,30). Gram et al showed that three months of endurance training in overweight adults reduces the risk of cardiovascular disease and balances hematological factors by reducing the factors involved in the blood coagulation process (31). Lamprecht et al reported platelet aggregation after strenuous walking in overweight obese women (32).

Table 2. Pre and post-training of body weight and BMI of studied groups.

Variables	Control group			Aerobic group			Aerobic + elastic group		
	Pre-test	post-test	*p*	Pre-test	post-test	*p*	Pre-test	post-test	*p*
Weight (cm)	93.5 (±2.99)	93.6 (±2.88)	0.780	93.31 (±2.81)	90.5 (±2.72)	0.001*	94.1 (±2.51)	89.38 (±2.44)	0.001*
BMI (kg/m2)	30.91 (±1.60)	30.94 (±1.53)	0.785	31.44 (±1.04)	30.56 (±0.91)	0.001*	31.46 (±1.35)	30.02 (±1.15)	0.001*

* represent significant level between pre and post-test (intra-group change: data by paired T-test)

Table 3. Test between subjects effects of each variables in studied groups

Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power
RBC	0.717	2	0.358	10.847	0.001	0.455	0.982
WBC	0.294	2	0.147	1.015	0.376	0.072	0.208
Hemoglobin	5.552	2	2.776	13.331	0.001	0.506	0.995
Hematocrit	90.044	2	45.022	55.319	0.001	0.810	0.999
Platelets	18150.283	2	9075.142	17.428	0.001	0.573	0.999

data by ANCOVA statistical test

Based on the above, anticoagulants such as heparin are used to treat DVT. The biological activity of heparin is dependent on the endogenous anticoagulant, antithrombin. Antithrombin inhibits coagulation factor proteases, especially thrombin IXa, IIa and Xa, by forming stable complexes. In the absence of heparin, these reactions are slow and accelerate up to 1000-fold in the presence of heparin. However, heparin use has side effects such as bleeding, increased reversible hair loss and baldness, osteoporosis, and spontaneous fractures. Heparin accelerates the clearance of blood lipids after a meal by releasing lipoprotein lipase from tissues (4,31,33). Therefore, researchers in the health sciences have introduced exercise as a low-risk treatment for mild to moderate DVT reduction. The findings of the present study revealed that aerobic exercise with elastic pressure in patients with DVT is associated with improvement and balance in hematological factors. In this study, standard compression stockings were used to create elastic pressure to correct and maintain deep venous hemodynamics as well as to prevent limb swelling in advanced CVI patients (2,31).

Stretch socks help pump the leg muscle and reduce venous blood pressure and venous valve reflux, which is accompanied by a reduction in edema and helps with blood circulation and prevents venous ischemia. Since the results of the present study showed that this effect was beneficial, it is likely that it corrects its abnormal reflex, thereby improving the function of the calf muscle pump and preventing limb edema (25,26). Therefore, standard compression stockings seem to have a direct effect on deep venous hemodynamics. This amount of elastic pressure facilitates the increase in blood pressure in the arteries by compressing the superficial tensile arteries, thus increasing the blood to the deep system in the "physiologically correct" state during exercise and aerobic activity. (19,34). Considering that the residual volume fraction (RVF) will be significantly reduced due to the use of resistance stockings (creating elastic pressure). Therefore, the use of elastic compression stockings creates a balance of hematology and platelet counts in DVT by creating elastic pressure during aerobic exercise (16,21).

Exercise increases beta-adrenergic activity, resulting in local release of norepinephrine into blood vessels (22). Catecholamines release some cytokines, and these inflammatory mediators are released during and after strenuous exercise (21). In fact, hemostatic balance depends on the interactions

Table 4. Difference between groups based on the Bonferroni post hoc test for each of the variables

Groups	Significant between each pair of groups			
	RBC	Hemoglobin	Hematocrit	Platelets
Control - Aerobic	0.999	0.707	0.999	0.999
Control – (Aerobic + Elastic)	0.010	0.001	0.001	0.001
Aerobic – (Aerobic + Elastic)	0.001	0.001	0.001	0.001

data by Bonferroni post hoc test

Table 5. Pre and post-training of hematological indexes of studied groups.

Variables	Control group			Aerobic group			Aerobic + elastic group		
	Pre-test	post-test	*p*	Pre-test	post-test	*p*	Pre-test	post-test	*p*
RBC	5.51 (±0.33)	5.49 (±0.27)	0.778	5.91 (±0.37)	5.82 (±0.38)	0.089	6.20 (±0.30)	5.61 (±0.19)	0.001*
WBC	7.26 (±0.80)	6.99 (±0.59)	0.225	7.24 (±0.96)	7.22 (±0.77)	0.871	7.38 (±0.93)	7.17 (±0.61)	0.192
Hemoglobin	15.5 (±0.49)	15.6 (±0.59)	0.528	16.01 (±0.77)	15.89 (±0.74)	0.204	16.98 (±0.99)	15.88 (±1.32)	0.001*
Hematocrit	48.8 (±1.70)	48.8 (±1.73)	0.519	49.8 (±1.64)	49.3 (±1.64)	0.059	5.5 (±2.01)	46.2 (±1.82)	0.001*
Platelets	251 (- 22)	246 (± 38)	0.645	267 (± 44)	257 (± 36)	0.108	281 (± 50)	216 (± 44)	0.001*

* represent significant level between pre and post-test (intra-group change: data by paired T-test)

of endothelial cells, blood cells, and the fibrinolysis coagulation system, and cytokines play an important role in this balance, and recent clinical and experimental evidence suggests that cytokines Both in physiological and pathological conditions are involved in the regulation of homeostasis balance (8,35), which results in increased thrombin. Thrombin converts fibrinogen to fibrin, platelet aggregation and clot formation. In the case of aerobic exercise and hematology indices, some reported no change and some decreased these indices (9). Quing et al noted that moderate-intensity aerobic exercise was inversely related to stamina hematological parameters as the amount of these factors decreased with increasing activity time. Some researchers have also pointed out that the intensity and time of activity strongly affect these factors.

In the present study, there was no change in white blood cell levels at low levels of training time and intensity. So that in the first two weeks it was 60% and in the last two weeks it was 70%. In this regard, it has been shown that regular aerobic exercise plays an important role in rebalancing homeostasis by reducing precoagulation factors and increasing anticoagulant factors (8). In the present study, the decrease in blood platelet count was also in the aerobic + elastic group compared to the control group and aerobic exercise group. Most studies indicate an increase in platelet count after exercise, which is inconsistent with the results of the present study. The increase in platelet count appears to be in response to the return of blood from the spinal cord, bone marrow, and the accumulation of intravascular blood from the lungs to the muscles involved in previous studies (36).

The possible mechanism of platelet depletion in the present study can be referred to the secretion of epinephrine, which leads to the elimination of all ions of all substances. Explain their reduction in exercise (9). The difference between most training protocols in other studies and the present study is in the intensity of training. In such studies, the intensity of training was much higher than our study. But other studies have reported a decrease or no change in platelet count after continuous subclinical activity. Perhaps the main mechanism of platelet depletion in response to aerobic exercise with elastic pressure can be attributed to the increase or non-change of blood PH due to adaptation to exercise, and in the present study as aerobic exercise was performed in the aerobic group without elastic pressure. The mentioned compatibilities have not been achieved. However, adaptation in the aerobic exercise group was accompanied by elastic pressure and the result was a significant reduction in platelet count, which plays an important role in improving DVT.

The findings of the present study revealed that despite weight loss and BMI reduction, aerobic training for 8 weeks alone is not able to improve hematological indexes in obese DVT patients, and this training method while combined with elastic pressure can be improve hematologic indices in these patients. Therefore, the use of pressure socks along with aerobic training is one of the strengths of this study. On the other hand, the importance and role of aerobic training along with pressure socks appear more when another group is included as an Elastic pressure group. In other words, it is possible that the improvement of hematological indicators in these patients can only respond to the use of pressure socks, not aerobic exercise. Therefore, the lack of Elastic pressure group is one of the main weakness and limitations of the present study.

Conclusions

Regular aerobic exercise combined with the use of elastic pressure on the muscles of the lower torso by reducing pre-coagulation factors and increasing anticoagulant factors plays an important role in rebalancing hemostasis and reducing hematological parameters in obese males with DVT. Therefore, the use of these training method combined with elastic pressure is recommended for this patients. Despite the evidence, the mechanisms responsible for the effects of exercise and elastic pressure on these variables are not well known and highlight the need for further studies in this field.

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Conflict of Interest

The authors report no conflicts of interest.

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