The effect of a moderate aerobic exercise on the blood coagulation markers in young non-athlete females

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Abstract

Introduction:
The effect of aerobic exercise on the blood coagulation system as a risk factor for coronary disease is still controversial. This study aimed to investigate the effect of a session of moderate aerobic exercise on some of the blood coagulation factors in the young girls.

Materials and Methods:
This interventional study was conducted on 11 healthy female volunteers aged 21 to 24 years, who had taken no systematic physical exercise for one year. This study was approved by the Ethics Committee of Kerman University of Medical Sciences. The performed protocol comprised 30 minutes of running with 70-75\% intensity of maximal heart rate reserved. Every volunteer donated blood for 3 times (before, immediately after and 30 minutes after the intervention), and the coagulation factors of Platelet count, Mean Platelet Volume, PT, aPTT, Fibrinogen and Factor VIII of plasma were measured. The data were analyzed using the repeated measures ANOVA.

Results:
Immediately after a session of aerobic exercise, the platelet count and factor VIII increased about 23\% (P= 0.001) and 75\% (P=0.004), respectively while aPTT decreased about 8\% (P= 0.007). PT showed a delayed increase observed 30 minutes after the exercise (P< 0.001).

Conclusion:
The results revealed that physical exercise, even with moderate intensity, activates some of blood coagulation markers and can lead to further side effects and probably a longer recovery. These findings would be helpful in adjusting the exercise intensity for the sedentary people, especially at the beginning of the training course.

Keywords: Aerobic Exercises, Blood Coagulation, aPTT Compound, Factor VIII

Introduction
Coagulation and fibrinolysis constitute two essential, counteracting physiologic processes in hemostasis and thrombosis formation (1). It is believed that disorders of the hemostatic system, including disorders of fibrinogen and partial thromboplastin time (aPTT) (1-9) leading to increased risk of cardiovascular diseases, are the result of changes in blood
coagulation (4, 5). Ischemic coronary syndromes, including unstable angina pectoris, myocardial infarction and sudden death secondary to heart ischemia, all share a common pathophysiology caused by heart thrombosis. According to Virchow’s triad and Bronck’s model, local changes in blood flow, injury of the vascular wall and consequently endothelial dysfunction are the main pathophysiological components in atherosclerosis and increased cardiovascular disease (2). Therefore, any disorder in hemostasis not only constitutes a risk factor for coronary heart disease, but also serves as a predicting factor for cardiovascular disorders (3).

As societies shift towards industrialization and individuals are increasingly adopting sedentary lifestyles, the rate of chronic diseases such as cardiovascular disorders is rising in the younger population. Lack of common risk factors, such as hyperlipidemia, hypertension, diabetes, etc in young people with myocardial infarction is in favor of the hypothesis that an imbalance in the hemostatic system may be to blame for thrombosis formation and myocardial infarction in this age group (10).

During recent years, numerous studies have been conducted on the relationship between dysfunction of the coagulation system and cardiovascular diseases, and their association with physical activity (11, 12). Aldemir et al demonstrated that one bout of aerobic activity with 70% maximal oxygen absorption leads to a significant increase in platelet counts (13). While some studies suggest that physical activity (performed with different protocols) has not significant impact on plasma fibrinogen (14), others report considerable increase (5, 15-16) or considerable decrease (17-19) in its level. Another coagulation factor influenced by activity is factor VIII (antihemophilia A, platelet cofactor II), synthesized in the liver and associated with venous thrombosis (20). It has been demonstrated that acute physical activity lowers active thromboplastin time and improves factor VIII activity (9).

The findings of some studies indicate that physical activity shortens the thromboplastin time (1, 21-22) with no effect on prothrombin time (8, 14). On the other hand, some researchers have reported increased thromboplastin and prothrombin time following different activities (9, 21). These reports indicate that the effect of physical activity on the coagulation system remains controversial. A more precise review of the studies conducted so far reveals that many factors, including age, anthropometric characteristics, daily changes, habits, diet, etc influence the components of the coagulation system (23, 24).

Physical activity exerts a considerable effect on the coagulation system based on its type, duration and intensity (25). Most studies dealing with the impact of exercise on the hemostatic system address the changes in coagulation factors after one bout of physical exercise in physically active individuals, especially athletes involved in endurance sports (17, 19). Rezaiean et al demonstrated that one bout of moderate exercise improves blood coagulation in active men more than inactive individuals (24). Considering the controversial results of the impact of exercise on blood coagulation especially fibrinogen, it is essential to assess these factors in early adulthood, particularly in young females who are physically inactive.

A large proportion of the society deal with exercise in a random fashion and usually as a leisure activity. Since it is unclear how the hemostatic factors respond to physical exercise and also the association between these factors and cardiovascular disorders is not clearly understood, it is crucial to investigate the changes in blood coagulation factors after one bout of exercise in order to prevent myocardial infarction. The question is, is there any association between the intensity of physical activity and fibrinogen? Are
random and irregular exercises helpful, or do they do more harm? The present study aims to determine how the coagulation factors in inactive individuals respond to one bout of aerobic activity with moderate intensity.

**Materials and Methods**

This is an interventional study on healthy girls aged 21-24 years recruited through voluntary convenience sampling. The participants were free of any disease including diabetes, cardiovascular disorders, asthma, hepatic disorders and hypertension. They had not engaged in any regular physical activity for a year. They were not obese or extremely thin (according to their body mass index) and were all in the follicular phase of their menstrual cycle. Once identified, the participants completed the consent form and a health questionnaire, and they were asked to abstain from nonsteroid anti-inflammatory drugs (such as ibuprofen, acetaminophen, aspirin) and contraceptive drugs during the 48 hours leading to blood sampling, and no drink tea, coffee or any other source of caffeine during the 24 hours preceding the test.

The exercise protocol consisted of warming up for 5 minutes, followed by 30 minutes of juggling at 70%-75% of maximal heart rate in a gym. The heart rate of the participants was measured after each round completed around a handball pitch with Polar pulse meter (Finland). After 12 hours of night fasting, each person donated 10 mL venous blood from the brachial vein between 7:30 and 8:30 a.m. three times — before, immediately after and 30 minutes after exercise.

Using the equation for determining sample size in clinical trials and considering a first-degree error of 0.05 and test power of 80%, we calculated the number of cases in each group to be 11 individuals. Using the results of Aldemir et al (13), the largest standard deviation of platelets was considered equal to 30 units, and the smallest significant difference was considered equal to 25 units. Measurements of activated thromboplastin time, prothrombin time, fibrinogen and factor VIII were made using Stago kit (STG, Australia) and Sysmex CA-1500. In addition, we used Sysmex K-21-N (Japan) to measure hemoglobin, hematocrit and changes in plasma volume. The participants’ height, weight and blood pressure were measured before and immediately after the exercise. In order to measure body fat, the participants’ subcutaneous fat was measured in triplicate at three spots of mid-arm, scapula, and chest using calipers (Nederland b.v.- Pondenral – Huidplooidikte-meter) and the mean value was recorded in millimeters. The findings are presented as mean and standard deviation. For the purpose of analysis, we first studied the normality of data distribution using Kolmogrov-Smirnov test. The changes in coagulation factors were assessed using analysis of variance with repeated measures and Bonferroni’s post hoc test on SPSS software version 18. P values ≤ 0.05 were considered significant. This study was approved in the Ethics Committee at Kerman University of Medical Sciences.

**Results**

In the present study, 11 girls aged 21-23 years were recruited with a mean age of 21.7 ± 0.8 years and a mean body mass index of 20.6 ± 3.1 Kg/m².

The platelet count experienced a significant 23% rise after exercise (p=0.001) which returned to normal half an hour after the exercise (p=0.999). Similarly, the mean platelet volume increased significantly after the exercise (p=0.003) and returned to its previous state half an hour later (p=0.999). On the other hand, the activated thromboplastin time reduced by 8% immediately after exercise (p=0.0070 which remain significant even after half an hour (p=0.013). The prothrombin time did not change...
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significantly immediately after exercise (p=0.102) but increased significantly half an hour later (p<0.001). Details of these changes are presented in Table 1. Fibrinogen activity was unchanged immediately after (p=0.981) and half an hour after the exercise (p=0.077). Factor VIII activity increased significantly by 75% immediately after the exercise (p=0.004) which remained significant after half an hour (p=0.007).

Table 1: Measurements of coagulation factors in girls (mean ± standard deviation)

<table>
<thead>
<tr>
<th>Coagulation Factors</th>
<th>Change</th>
<th>Before exercise</th>
<th>Immediately after exercise</th>
<th>P Value (vs. before)</th>
<th>½ hrs. after exercise</th>
<th>P Value (vs. before)</th>
<th>P value (vs. after)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platelet count (Plt) (x 10^9/L)</td>
<td>232.6±41.8</td>
<td>286.1±35.9</td>
<td>0.001</td>
<td>235.6±52.3</td>
<td>0.999</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>Mean platelet volume (MPV) (μm³)</td>
<td>10.38±0.73</td>
<td>107.5±0.65</td>
<td>0.003</td>
<td>10.41±0.85</td>
<td>0.999</td>
<td>0.123</td>
<td></td>
</tr>
<tr>
<td>Prothrombin time (PT) (s)</td>
<td>11.27±0.42</td>
<td>11.05±0.43</td>
<td>0.102</td>
<td>11.54±0.4</td>
<td>0.008</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Activated thromboplastin time (aPTT) (s)</td>
<td>31.47±2.98</td>
<td>29.19±3.48</td>
<td>0.007</td>
<td>29.65±2.97</td>
<td>0.013</td>
<td>0.730</td>
<td></td>
</tr>
<tr>
<td>Fibrinogen (g/dL)</td>
<td>2.87±0.43</td>
<td>2.99±0.43</td>
<td>0.981</td>
<td>2.73±0.31</td>
<td>0.077</td>
<td>0.031</td>
<td></td>
</tr>
<tr>
<td>Factor VIII (%)</td>
<td>103.5±35.4</td>
<td>180.7±80.3</td>
<td>0.004</td>
<td>153.9±60.2</td>
<td>0.007</td>
<td>0.009</td>
<td></td>
</tr>
</tbody>
</table>

Discussion
The findings of the present study indicate that one bout of aerobic exercise increases platelet count and mean platelet volume. Previous studies have demonstrated that physical activity improves platelet count, which may be associated with release of fresh platelets from the vascular beds of the spleen, bone marrow and other platelet reservoirs (26). Moreover, other studies indicate that epinephrine causes a strong contraction of the spleen (where 1/3 of body platelets are stored); as epinephrine levels rise in physical activity (especially intense exercise) (27), this may account for elevated level of platelets after exercise. Some studies even suggest that waking up in the morning (a very mild physical activity) may raise the level of platelets in bloodstream (13). Aldemir et al demonstrated that one bout of aerobic exercise in the morning with 70% maximal oxygen absorption elevates platelet counts significantly (13). This is consistent with findings of Yves Cadroy and Riberio who studied platelet counts in inactive individuals after one bout of acute activity in the morning (22, 25). Ahmadizad et al assessed the impact of three resistance exercises at 40%, 60% and 80% maximal intensity on platelet activation and concentration to observe a significant elevation in platelet counts at all three intensities of exercise (28). Prothrombin time is an index of the extrinsic pathway of coagulation and its length depends on prothrombin concentration. The findings of the present study indicated that increased prothrombin time occurs in a delayed fashion, as it is unchanged immediately after the exercise, but rises half an hour later. Few studies have observed similar trends in patients with diabetes or hypertension (15, 29). Piccione et al have also demonstrated increased prothrombin time after short-term aerobic exercise. According to them, the discrepancies in prothrombin time response lag in different studies reassure us that the type of exercise influences the response of the coagulation system, besides other factors such as age, sex and initial conditions (23). Since prothrombin is synthesized in the liver and changes in hepatic perfusion may affect its synthesis (25), it is possible that the prolonged prothrombin time may be the result of reduced liver perfusion. Activated thromboplastin time, which is much slower than the prothrombin time,
serves as an index for the intrinsic pathway which begins with vessel injury and blood coming in contact with collagen in the injured vessel wall. Physical exercise activates endothelial cells and stimulates the release of von Willbrand factor (15). The thromboplastin time reduced significantly immediately after and half an hour after exercise. Similarly, Menzel and Hilberg demonstrated significant shortening of thromboplastin time after moderate exercise at 80% of anaerobic threshold in young and elderly men (21). Furthermore, other studies have reported substantial reductions in activated thromboplastin time after exercise with different protocols (15, 24, 30).

In the present study, fibrinogen activity did not change before, immediately and 30 minutes after exercise, which is consistent with findings of Rankinen et al who did not find any change in fibrinogen after exercise in healthy active men (31). The findings of some studies, in line with ours, indicate that physical activity with different protocols has no significant impact on plasma fibrinogen (14, 31), whereas some studies report considerable increase (16, 32-33) or considerable decrease (17-19). It may be stated that changes in fibrinogen is most probably related to the type of physical activity rather than the participant. Cerneca et al reported that rowers, marathon runners and healthy individuals in the control group indicate a significant rise in plasma fibrinogen after maximal exercise, while no such effect was observed in weight lifters (34).

The activity of factor VIII improved significantly immediately and half an hour after exercise. Ribeiro et al also reported an increase in factor VIII immediately after and an hour after exercise in inactive adolescents (24). It is said that during exercise, beta-adrenergic receptors are stimulated which results in increased thrombin production. Factor VIII production is probably under the influence of thrombin (35). Changes in thromboplastin time with exercise are consistent with changes in factor VIII level, as thromboplastin time is greatly influenced by actor VIII (36).

Another influential factor on the response of the coagulation system is age, as individuals at different ages may not respond similarly. In addition, whether or not changes in the coagulation system translate into thrombos formation and its complications requires concurrent assessment of the fibrinolysis system. Considering the limitations of our present study, including use of the minimum acceptable sample size, the results can only be applied to the exercise protocol used (moderate aerobic activity) in inactive girls with a mean age of 22 years.

**Conclusion**

According to the present study, one bout of moderate aerobic activity activates certain coagulation factors. In general, it may be said that exercises with such pattern do not raise the risk of thrombosis considerably. We recommend that the intensity of exercise should be adjusted for inactive individuals, particularly at the onset of the exercise course.

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