Correlation Between Exercise Induced Lactic Acidosis and Leucocytosis

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Background: Short lasting strenuous physical exercise leads to a marked change in peripheral leucocyte number which is assumed to be diagnostically informative and may be a prognostic marker. Lactic acidosis also develops after intense exercise of short duration, at a metabolic rate that is specific to the individual and the task being performed. This study was done to observe the effects of intensity and duration of exercise on blood lactic acid and total leucocyte count. Furthermore to find out the possible correlation between exercise induced lactic acidosis and leucocytosis.

Methods: Two groups, each consisting of fifteen normal healthy male adults, were exercised on treadmill. Group-I performed exercise by running for a duration of 2-3 minutes, at 7% grade (4 degree inclination) and at constant speed ranging from 7.5 to 9 km/hour while group-II subjects walked on treadmill for a duration of 7-10 minutes, at zero grade and at constant speed ranging from 5 to 6 km/hour. Blood samples were drawn before and after exercise. Total leucocyte count was determined manually using an improved Neubauer hemocytometer and lactic acid in the blood was determined colorimeterically by Spectronic 21.

Results: The total leucocyte count increased significantly ($P<0.001$) by 83.145% and 59.746% after exercise, in groups I and II respectively; group-I vs group-II $P<0.1$. While the blood lactic acid significantly increased ($P<0.001$) by 43.197% and 27.273% after exercise, in groups I and II respectively group-I vs group-II $P>0.01$. The correlations between post-exercise values of blood lactic acid and total leucocyte count of group-I and group-II subjects were $r = 0.278$ ($P <0.5$) and 0.201 ($P <0.5$), respectively.

Conclusion: It is clearly reflected by this study that the magnitude of exercise induced lactic acidosis and leucocytosis is higher in exercise of more intensity and less duration. Although the correlation between post-exercise blood lactic acid concentration and total leucocyte count was weak and non-significant but was found in both groups. So, the exercise induced lactic acidosis may play at least some role in inducing post-exercise leucocytosis.

Key Words: Exercise, leucocytosis, lactic acidosis.

Introduction

Regular exercise training is a form of physical activity and may offer insight into the body,s response after being subjected to regular strenuous activity[1].Immune response is often induced with an increase in leucocyte number following strenuous activity[2,3] and this change in peripheral leucocyte number is assumed to be diagnostically informative and may be a prognostic marker, reflecting organ damage and restoration[4].

Performance of treadmill exercise is found to induce the well known phenomenon of leucocytosis[5,6] the intensity of which is being proportional to the intensity of work and duration of exercise[7]. Endurance exercise of different intensity and duration cause significant leucocytosis[8] but is of same magnitude after treatment with supplemental oxygen or compressed air[9]. Moderate exercise of duration less than 2 hours elicits lower changes in cell concentrations and hormonal responses than strenuous exercise of duration more than 2-3 hours. The neutrocytosis following exercise is more dependent on the duration than on the intensity of exercise[10].

Lactic acidosis develops at a metabolic rate that is specific to the individual and the task being performed. This is typically caused by an inadequate oxygen supply to the mitochondria[11]. There is a tendency for high power output to be associated with a high blood lactic acid concentration and a low pH[12]. The blood lactic acid concentration is 5-8 millimoles/liter larger for exhausting bouts compared with non-exhausting bouts of exercise[13]. Lactate production is likely to delay the onset of exercise induced acidosis, because it serves to consume hydrogen ions and allows their transport from the cells[14]. Latest findings have led to the idea that lactate/hydrogen ions are ergogenic during exercise[15]. There is a transient leucocytosis and an increase in plasma lactic acid after intense exercise of short duration[16].

As there is an increase in both the number of circulating leucocytes and concentration of lactic acid in blood after exercise. This study was done to observe the effects of intensity and duration of exercise on blood lactic acid and total leucocyte count. Furthermore to find out the possible correlation between exercise induced lactic acidosis and leucocytosis.

Material and Methods

This study was conducted in the Department of Physiology, Basic Medical Sciences Institute, Jinnah Postgraduate

Medical Centre, Karachi. Thirty subjects were selected from the students, staff and residents of Jinnah Postgraduate Medical Centre, Karachi according to the following criteria:

- Normal healthy male adult subjects.
- Age ranging from 18 to 45 years.
- Weight ranging from 50 to 85 kilograms.

On the experimental day, a general physical examination of each volunteer was made.

The procedure of treadmill exercise was explained to all the study participants prior to exercise. A continuous monitoring of treadmill belt velocity was observed throughout the test[17].

The selected subjects were divided into two groups and the subjects of each group were exercised on the treadmill, AR-160A (Minato Medical Science Company, Japan), as follows:

Group-I (n=15)

The treadmill exercise was performed by running for a duration of 2-3 minutes, at 7% grade (4 degree inclination) and at constant speed ranging from 7.5 to 9 km/hour.

Group-II (n=15)

The treadmill exercise was performed by walking for a duration of 7-10 minutes, at zero grade and at constant speed ranging from 5 to 6 km/hour.

Each subject was allowed a 30 minutes rest period before taking pre-exercise blood sample. After taking the first sample, each subject was asked to do exercise on treadmill (as mentioned above). Second sample of blood was taken immediately after exercise. The samples were then analyzed by standard methods and the results were statistically evaluated. Total leucocyte count was determined manually using an improved Neubauer hemocytometer and lactic acid in the blood was determined colorimeterically by Spectronic 21 (Milton Roy Company Lactic acid). Correlation between blood lactic acid concentration and total leucocyte count was assesed by caculating "r" and "P" values.

Results

The pre and post-exercise total leucocyte counts of both the groups (alongwith the differences, percent variation and significance) are given in table 1. Table 2 gives the pre and post-exercise blood lactic acid concentrations (alongwith the differences, per-cent variations and significance) of both the groups. Table 3 shows the "r" and "P" values of post-exercise total leucocyte count and blood lactic acid concentration of both the groups. A comparison of post-exercise blood lactic acid (P>0.01) and total leucocyte count (P< 0.1), between group-I and group-II, is given in table 4.

Table 1: *Total Leucocyte Count Group- I and Group-II.*

Groups	Pre-exercise (Cells/μl)	Post-exercise (Cells/μl)	Mean of differences ± S.E.M.	%Variation	P-value
I	9750 ± 384.477	17856.667 ± 1213.240	8106.667 ± 1022.642	+ 83.145	< 0.001
II	10266.667 ± 307.602	16336.667 ± 866.301	6110.00 ± 746.03	+ 59.746	< 0.001

(n = 15) + = Increase

Table 2: *Blood Lactic Acid Group-I and Group-II.*

Groups	Pre-exercise (mg/dl)	Post-exercise (mg/dl)	Mean of differences ± S.E.M.	%Variation	P-value
I	10.723 ± 0.699	15.355 ± 1.361	4.60 ± 1.083	+ 43.197	< 0.001
II	10.89 ± 0.710	13.86 ± 1.510	2.97 ± 0.660	+ 27.273	< 0.001

(n = 15) + = Increase

Table 3: *Correlation of Post-Exercise Blood Lactic Acid and Total Leucocyte Count Group-I and Group-II.*

Groups	Total leucocyte count (Cells/μl)	Blood lactic acid (mg/dl)	r-value	P-value
I	16336.667 ± 3355.169	13.86 ± 1.510	0.201	< 0.5
II	17856.667 ± 1213.241	15.355 ± 1.361	0.278	< 0.5

(n = 15)

Discussion

Total leucocyte count was significantly (P<0.001) increased after exercise, by 83.145% in group-I and 59.746% in group-II. The magnitude of post-exercise increase in total leucocyte count was higher in group-I but was insignificant (P<0.1) when compared with group-II. These findings are similar to those reported by Kayashima *et al.* (1995) and McCarthy *et al.* (1987), who observed an increase of 90% and 115%, respectively. The incre-

ase in total leucocyte count reported by these researchers was slightly more because the exercise stress was more severe than the present study. Gabriel and Kindermann (1997) reported that moderate exercise elicits lower changes in cell concentration than strenous exercise.

Blood lactic acid was significantly (P<0.001) increased after exercise, by 43.197% in group-I and 27.273% in group-II. The magnitude of post-exercise increase in blood lactic acid was significantly (P>0.01) higher in group-I than group-II. Medbo (1987) reported similar findings about blood lactic acid after exercise that the blood lactic acid concentration was larger for exhausting bouts compared with non-exhausting bouts of exercise. Cheetham and Williams (1985) have also reported a significant increase in blood lactic acid concentration after exercise and a tendency for a high power output to be associated with a high blood lactic acid concentration. Increases in blood lactic acid after exercise is observed by many other workers.[18,19]

Table 4: *Comparison of Post-Exercise Blood Lactic Acid and Total Leucocyte Count Between Group-I and Group-II.*

Parameter	Group-I	Group-II	P-value
Blood lactic acid (mg/dl)	15.355 ± 1.361	13.86 ± 1.510	> 0.01
Total leucocyte count (Cells/μl)	17856.667 ± 1213.241	16336.667 ± 3355.169	< 0.1

(n=15)

The cause of exercise induced leucocytosis has not been definitely identified, although there is a hypothesis that rheological and hemodynamic factors may be important in this process[20]. Circulatory responses to exercise normally are closely coupled to skeletal muscle metabolic rate. Regulation is achieved in part by reflexes that originate in working muscle and are activated by metabolities (e.g. lactic acid) produced in response to muscle energy demands[21]. Thus, there is a possibility that exercise induced lactic acidosis may either directly or indirectly (through circulatory responses) be responsible for exercise induced leucocytosis. To see any role of blood lactic acid concentration in exercise induced leucocytosis, the correlation of post-exercise changes in blood lactic acid concentration and total leucocyte count was calculated in group-I and group-II. The results of correlation in the present study were statistically non-significant but the r-values were in the range of weak degree of association (r = 0.278 for group-I and 0.201 for group-II). Previous research work about this correlation (to the best of our knowledge) is not yet published.

Further studies are suggested in this regard by infusing lactic acid into resting animals and observing its effects on total leucocyte count.

Conclusion

By studying the effects of exercise on blood lactic acid concentration and total leucocyte count in two groups of subjects, who were exercised for different intensities and durations. The present study has clearly indicated that the magnitude of exercise induced lactic acidosis and leucocytosis depends upon the intensity and duration of exercise (higher in exercise of more intensity and less duration). Although the correlation between post-exercise blood lactic acid concentration and total leucocyte count was weak and non-significant but was found in both groups. So, the exercise induced lactic acidosis may play at least some role in inducing post-exercise leucocytosis.

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