ORIGINAL ARTICLE

CORRELATION BETWEEN PRE AND POST EXERCISE BLOOD LACTATE AND pH

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ABSTRACT

Background: The body's response to strenuous activity can be observed by subjecting it to exercise. During exercise lactic acid is produced in the skeletal muscles leading to decline in intracellular pH. Other anions and sodium/hydrogen exchange could also account for acidosis. The aim of this study was to observe the effect of intensity and duration of exercise on blood lactate and pH.

Material & Methods: This study was conducted in Department of Physiology, Basic Medical Sciences Institute, Jinnah Postgraduate Medical Centre, Karachi. Thirty male, adult subjects were selected and divided into two groups. Subjects of each group were exercised on treadmill. Group-I subjects performed exercise by running for 2-3 minutes at 7% grade and speed of Km/hour and Group-II subjects performed exercise by walking for 7-10 minutes, at zero grade and speed of 5-6 Km/hour. Pre and post exercise blood samples were taken for lactate and pH estimation.

Results: Increase in blood lactate after exercise was more in Group-I subjects (43.197%, $p<0.001$) than Group-II (27.273%, $p<0.001$). Blood pH decreased significantly after exercise by 100% in both groups ($p<0.001$). In Group-I the correlation between post-exercise blood lactate and pH was negligible ($r=0.140$, $p>0.5$) while in Group-II a week degree of correlation was found ($r=0.317$, $p<0.5$).

Conclusion: The magnitude of post-exercise changes in blood lactate and pH depend upon the intensity and duration of exercise but correlation between post-exercise blood lactate and pH is weak and non-significant.

Key words: Exercise, Lactate, pH.

INTRODUCTION

Exercise is a form of physical activity and may offer insights into how the body responds after being subjected to regular strenuous activity.[1] During exercise lactic acid is produced in skeletal muscle cells by glycogenolysis, typically caused by an inadequate oxygen supply to the mitochondria and the accumulation of lactic acid causes intracellular pH to decline. This lactic acidosis develops at a metabolic rate that is specific to the individual and the task being performed.[2] The rate of lactate production and the fall in blood pH is higher in the sprinter than in the marathon runners.[3]

The capacity to perform maximal exercise, during brief maximal dynamic exercise, is enhanced following training but increases in muscle and blood lactate remain unchanged.[4] Although other substrates, such as glucose, can enter glycolysis and lead to pyruvate production, only glycogenolysis can provide enough glucosyl units to result in excess lactate production and intracellular acidosis. Depletion of stored skeletal muscle glycogen impairs glycogenolysis and thus lessens the capacity of a muscle cell to make lactate. So the fall in pH is attenuated under conditions in which glycogen availability is reduced.[5]

Though there is a modest relationship between blood pH and blood lactate concentration following exercise[6] but in addition to lactate, the total sum of other anions such as proteins, phosphate, pyruvate, citrate, free fatty acids and amino acids, as well as sodium hydrogen exchange could account for the supervening acidosis.[7]On the other hand lactate production may be more likely to delay the onset of acidosis because it serves to consume hydrogen ions and allows the transport of hydrogen ions from the cells.[8] Latest findings have led to the idea that lactate/hydrogen ion is ergogenic during exercise.[9]

The present study was conducted to observe the effects of intensity and duration of exercise on blood lactate and pH as well as to see any possible correlation between exercise induced changes in blood lactate and pH.

MATERIAL AND METHODS

This study was conducted in the Department of Physiology, Basic Medical Sciences Institute, Jinnah Postgraduate Medical Centre, Karachi. Thirty male adult subjects were selected from the students, staff and residents of Jinnah Postgraduate Medical Centre, Karachi.

The procedure of treadmill exercise was explained to all the study participants prior to exercise. Continuous monitoring on treadmill was observed throughout the test.[10]

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: Fifteen subjects performed the treadmill exercise by running for a duration of 2-3 minutes, at 7% grade (4 degree inclination) and speed ranging from 7.5 to 9 Km/hour.

Group-II: Fifteen subjects performed the treadmill exercise by walking for a duration of 7-10 minutes, at zero grade and speed ranging from 5-6 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 statistically evaluated. Blood lactate was determined colorimeterically by Spectronic-21 (Milton Roy Company) and Blood pH was measured electrometrically with the glass electrode by digital pH meter 2002 (Good Company).

RESULTS

The pre and post-exercise blood lactate of the two groups are given in Tables-1 and pH in Tables-2. While tables 3 and 4 give the "r" and "p" values of post-exercise blood lactate and pH of both the groups.

Table-1: Blood lactate of Group-I & II.

Group	Pre-exercise (mg/dl)	Post-exercise (mg/dl)	Mean of differences ± SEM	% variation	p-value
Group-I (n=15)	10.723±0.699	15.355±1.361	4.60±1.083	+43.197	< 0.001
Group-II (n=15)	10.89±0.710	13.86±1.510	2.97±0.660	+27.273	< 0.001

Key: SEM = Standard Error of the Mean, + = Increase

Table-2: Blood pH of Group-I & II.

Group	Pre-exercise (mg/dl)	Post-exercise (mg/dl)	Mean of differences ± SEM	% variation	p-value
Group-I (n=15)	7.381±0.005	7.22±0.016	-0.161±0.013	-100.00	< 0.001
Group-II (n=15)	7.378±0.005	7.257±0.018	-0.121±0.015	-100.00	< 0.001

Key: SEM = Standard Error of the Mean, – = Increase

Table-3: Correlation of Post-exercise Blood Lactate and pH in Group-I & II.

	Blood lactate (mg/dl)	Blood pH	r-value	p-value
Group-I (n=15)	15.355±1.361	7.22±0.016	0.140	> 0.5
Group-II (n=15)	13.86±1.510	7.257±0.018	0.317	< 0.5

DISCUSSION

The pattern of percent variation of blood lactate after exercise was same in the two groups but the magnitude of variation was different. The increase in blood lactate immediately after exercise was more in group-I subjects (43.197%, $P<0.001$) than group-II subjects (27.273%, $P<0.001$). Increase in blood lactate immediately after exercise was also observed by many other workers.[11,12,13] The blood lactate concentration is also reported to be larger for exhausting bouts compared to non-exhausting bouts of exercise and a tendency for a high power output to be associated with a high blood lactate concentration.[6,14]

Like blood lactate, the pattern of percent variation of blood pH was also similar in the two groups. The blood pH decreased significantly ($P<0.001$) immediately after exercise by 100% in both groups I and II. The decrease in pH after exercise is also reported by other workers.[6,11,12,15]

The results of correlation between post-exercise changes in blood lactate concentration and blood pH were statistically non-significant and different in the two groups. In group-I this correlation was negligible ($r=0.140$), while in group-II a weak degree of correlation was found ($r=0.317$). Existence of a modest relationship between blood pH and blood lactate concentration following the exercise is previously reported.[6] Other workers have reported marked consistent changes in lactate but pH changes ranging from 0.06 to + 0.04, this is because pH reflects the dynamic balance between lactic acid production and carbon dioxide lost by ventilation both of which are changing rapidly by the end of the exercise period.[16] Lactate also serves to consume hydrogen ions.[8] Further suggestion is that other anions such as proteins, phosphate, pyruvate, citrate, free fatty acids and amino acids could also account for the acidosis after exhausting exercise.[7]

CONCLUSION

The magnitude of post-exercise changes in blood lactate and pH depends upon the intensity and duration of exercise. But the correlation between post-exercise blood lactate and pH is weak and non-significant, suggesting other possible causes such as pyruvate, phosphate and citrate ions for post-exercise acidosis.

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