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RESEARCH ARTICLE

A study of lactate accumulation and changes in vital data during exercise on a bicycle ergometer

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ABSTRACT

Background: It is common to use blood lactate for the determination of performance as well as for the development of training exercises in athletes. **Aims and Objectives**: The purpose of this study was to gain better understanding of blood lactate concentration which is increased almost 3-4 folds, after the subject complained of subjective feeling of fatigue while exercising on a bicycle ergometer. **Materials and Methods:** The study was conducted on 50 adolescent participants of the age group of 16-19 years with body mass index 18-25. Before testing, the participants' height and weight were measured. Blood pressure (BP), respiratory rate (RR), and heart rate (HR) were recorded in the supine posture, and 2 cc of blood was collected for measurement of blood lactate level. After cycling for some time when the participant complained of feeling of fatigue then the time was recorded and asked to stop exercising then the subject was advised to lie down supine on the bed and one blood sample collected after recording BP, HR, and RR. Data were recorded in the case record form. Paired *t*-test was used to compare the mean values of parameters before and after test. **Results:** Blood lactate levels before exercise with a mean value of 10.1604 mg/dl and blood lactate after exercise with mean value of 33.809 mg/dl. Paired *t*-test on the computed mean difference between two blood samples at rest and post exercise revealed that they were statistically significant with a probability of $P < 0.001$. **Conclusion:** It is advantageous for clinicians to have a good understanding regarding blood lactate and its clinical implications. While an elevated level may be indicative of ischemia or hypoxemia, it may also be a normal physiological response to exertion.

KEY WORDS: Exercise; Fatigue; Adolescents; Bicycle Ergometer; Blood Lactate Level

INTRODUCTION

Measuring exercise performance is a major topic of interest in the world of exercise physiology as well as in athletics. Assessing lactate threshold during exercise has been a well-investigated method of exhausting athletic performance by determining blood lactate levels; training status of a given athlete can be used to multipulate a training prescription.[1] At the onset of the exercise, ready energy materials are used and lactate is not formed. Later lactate is formed since the energy is obtained by breaking down of glycogen without oxygen.[1] Lactate thus formed is eliminated by the buffer systems of the organism. However, when lactate production is excessive, it accumulates in the muscles and the blood. Lactate measurements during exercise yield information on the intensity of the workload and its duration. At the onset of incremental exercise, there are minimal changes in blood lactate with the rate of diffusion from the muscle matched by the rate of removal from the blood. As exercise intensity increases a point is reached where lactate rises rapidly.[1] There are no sex differences in blood lactate accumulation with exercise during youth. Children accumulate less blood

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lactate than adults during submaximal and maximal exercise. No study has specifically examined the potential mechanisms underline training-induced reductions in young people's blood lactate accumulation during subsequent submaximal exercise but data from studies of adults suggest that an increase in oxidative capacity is the primary mechanism.[2]

Most athletes and coaches still believe that lactic acid is released during hard or unaccustomed exercise and this is what limits performance, as well as being the cause of stiffness. Neither is correct. Furthermore, the terminology lactic acid is not correct. Lactic acid does not exist as such in the body, it exists as lactate at physiological pH and when the lactic acid concentration is measured in blood when a lactate threshold is reached in an athlete. This distinction is important not only for the sake of correctness but also more importantly because lactate and lactic acid would have different physiological effects. The first misconception is that lactic acid is the cause of the stiffness felt after an event such as a marathon. Stiffness is due to damage to the muscle and not due to an accumulation of lactic acid crystals in the muscle as is commonly believed.[3]

The second misconception is that lactate is responsible for acidifying the blood, thereby causing fatigue. To the contrary, the production of lactate is actually important for two reasons. First when lactate is produced from pyruvate in the muscle, a hydrogen ion is consumed in this process, consequently, the production of lactate actually reduces the acidity in the muscle cells and is thus a beneficial process. Second, lactate is an important fuel that is used by the muscled during prolonged exercise. It can be produced in one muscle cell and utilized as a fuel in another or it can be released from the muscle and converted in the liver to glucose which is then used as an energy source. So rather than cause fatigue lactate production actually helps to delay fatigue.[4]

As far as blood pressure (BP) was concerned, there was a rise in systolic BP (SBP) and a drop in diastolic BP (DBP) values during exercise. Under resting conditions, the arterial barow reflex mechanism increases BP and induces a decrease in heart rate (HR). During muscular exercise, the concomitant increase of arterial pressure and HR occurs indicating that arterial barow reflex control is modified during exercise. During exercise, cardiac output is increased because of squeezing blood into the veins. Respiration increases to provide that oxygen and removal of CO_2 are done by increase in breathing rate by about 3 times the normal rate and increase in tidal volume by 5 times the normal rate.[5]

Objectives

i. To study the amount of lactate accumulation after exercise on a bicycle ergometer in male adolescents with body mass index (BMI) 18-25.
ii. To recording of changes in vital data HR, respiratory rate (RR), SBP, DBP and blood lactate levels immediately before and after exercise.

MATERIALS AND METHODS

The study was conducted on 50 participants selected from the 1st year students of Siddhartha Medical College in the adolescent age group (16-19 years) with BMI 18-25 and who are not previously exercising regularly. The dissertation committee of the institute approved the study protocol. Proper instructions and detailed procedure explained and consent was taken before the exercise testing. The subjects were instructed not to exercise for 24 hrs before the testing.

Before testing, the participants' height and weight were measured. BP, RR, HR were recorded in supine posture, and 2 cc of blood was collected from the anterior cubital vein under aseptic conditions with a disposable syringe and needle into a test tube containing anticoagulant (sodium fluoride) just before exercise to determine the lactate level. After the participant was seated on the ergometer (ergometric bicycle SHARP FIT, DOUBLE SIX-909), the handle bar was moved both horizontally and vertically to make it comfortable to the participant then the participants were encouraged to do cycling and the time was recorded. After cycling for some time when the participant complained of feeling of fatigue then the time was recorded and asked to stop exercising, then the subject was advised to lie down supine on the bed and one blood sample collected after recording BP,HR and RR. Kinetic colorimetric measurement of serum lactate dehydrogenase activity is noted. A kinetic colorimetric assay procedure is described for measuring lactate dehydrogenase activity, in which the reduction of NAD is coupled to the reduction of tetrazolium salt, 2-p-iodophenyl-3-p-nitrophenyl-5-phenyl tetrazolium chloride (INT), with phenazine methosulfate serving as an immediate electron carrier. The molar absorptive of the farm zone of INT was found to be 19.3 × 10 at 503 nm, which provides a 3-fold increase in the sensitivity of the ultraviolet (340 nm) kinetic assay the results correlate well with those obtained by 340 nm kinetic methods, and the procedure does not require an ultraviolet spectrophotometer. The method is simple and rapid and does not rely on secondary enzyme standards it requires only two reagents which are stable.

Data were recorded in case record form. Paired *t*-test was used to compare the mean values of parameters before and after test. $P < 0.05$ denoted the statistically significant difference in the compared parameters.

RESULTS

Mean of blood lactate level before exercise was 10.160 mg/dl and the after exercise was 33.809 mg/dl and it was highly significant at ($P < 0.001$). The mean of total time at which

the subject has expressed feeling of fatigue was 318.28 s. The mean of HR before exercise was 78.38 and after exercise was 112.1 and found highly significant with $P < 0.001$. Mean of RR before exercise was 14.2/min and after exercise was 22.04/min and was found highly significant with $P < 0.001$. The mean of SBP before exercise was 97.2 mmHg and after exercise was 128 mmHg and was found highly significant with $P < 0.001$. While, mean of DBP before exercise 70.8 mmHg and after exercise was 70.64 mmHg and was found not significant ($P > 0.05$) (Table 1).

DISCUSSION

Blood lactate level is one of the most often measured parameters during clinical exercise testing and during performance testing of athletes. An elevated blood lactate may be used to evaluate an underlying pathology during a routine stress test (coronary artery disease, chronic airway obstruction, chronic renal failure, metabolic impairment).[6] In this study, mean of blood lactate level before exercise was 10.160 mg/dl and the after exercise was 33.809 mg/dl and it was highly significant at ($P < 0.001$). According to the other studies, the blood lactate level generally reaches peak values approximately 80 mg/dl in 3-5 min after the exercise and lactate values measured after exercise depends on exercise time, exercise intensity and training condition of the subjects.[1,7,8] Increases in blood lactate characterize a normal response to exercise if a patient exceeds the work rate at which lactate can be removed from the blood as quickly as it enters the blood.[8] Elevations of blood lactate may not necessarily indicative of either ischemia or hypoxemia.[9] Hence, interpretation of blood lactate is complicated.

The importance of knowing the arterial pressure response to exercise in children and adolescents has been a focus of several studies in many countries.[10] In most studies, children and adolescents were evaluated using multi-stage protocols particularly the treadmill test developed by Bruce in this series no difference was observed in resting DBP. Increasingly, greater values were observed with age mainly from 16 years in both genders in this study.

Table 1: Change in different parameters before and after exercise

Variables	Mean before	Mean after	*P* value	Inference
Blood lactate (mg/dl)	10.1604	33.809	<0.001	Highly significant
HR (rate/min)	78.38	112.1	<0.001	Highly significant
RR (rate/min)	14.2	22.04	<0.001	Highly significant
SBP (mmHg)	97.2	128	<0.001	Highly significant
DBP (mmHg)	70.8	70.64	>0.05	Not significant

HR: Heart rate, RR: Respiratory rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

As the behavior of BP during physical exertions, SBP levels for adolescents at maximal exertions are not expected to exceed 200 mmHg. A significant increase in DBP during physical exertion in uncommon and usually the values at rest either drop or remain unchanged studies conducted on adolescents using Bruce protocol have consistently reported a SBP behavior similar to that observed in adults that are a raise in tension levels with exercise. However, the same studies are controversial as to DBP since some have shown a drop in DBP, whereas others have reported the maintenance of the levels observed at rest in seldom and raise in diastolic tension levels.[11] The findings in this study were similar to those reported in medical literature that is raise in SBP and drop in DBP levels during physical exercise for both genders in all age groups.

The similar finding reported by Ahmad et al.[12] in which the greatest variations in SBP were observed in the age groups over 14 years for both the genders. The exertion DBP variation was also greater among males but it shows a drop with exercise in both genders for all age groups evaluated. This DBP behavior during exercise is different from that of other studied that reported unchanged DBP levels during exercise or a tendency to decrease. In this study, the mean of SBP before and after exercise was 97.2 mmHg and 127 mmHg, respectively, in this DBP mean variations before and after exercise were 70.8 mmHg and 70.64 mmHg indicating a fall in DBP after exercise.

CONCLUSION

It is advantageous for clinicians to have a good understanding regarding blood lactate and its clinical implications. While an elevated level may be indicative of ischemia or hypoxemia, it may also be a normal physiological response to exertion.

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