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Original article

Investigation of the effects of sodium bicarbonate intake on the lactic acid, heart rates and aerobic performance in elit mountain cyclists

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Abstract. The aim of this study was to investigate the effects of sodium bicarbonate intake on the lactic acid, heart rate and aerobic performance in elite mountain cyclists. Ten cyclists, who were licensed, participated in the study between 20 and 23 years of age. In the study, 0,3 g/kg body weight dosage $NaHCO_3$ substance was given orally by mixing 500 ml fruit juice 2 hours before the test. In order to see the Lactate Acid (LA) levels of the athletes, the ergonomics bicycle ergometer test was applied with the Monark brand 839E model ergometer. According to $NaHCO_3$ intake status, Lactate Measurements, HR, Burnout Time and Distance traveled were recorded. The data obtained from the lactic acid studied in the study were analyzed by repeated measures ANOVA analysis technique in factorial order. In the determination of the difference between the athletes before and after the test, "in-group Paired t test" was applied. The significance level was evaluated according to "0,05" significance level. There was a statistically significant difference between the two groups of LA values before and after receiving $NaHCO_3$ ($p < 0,05$). However, there was a more significant decrease in LA values after $NaHCO_3^+$ administration. Comparing the $NaHCO_3$ uptake status of the LA values before and after taking $NaHCO_3$, no significant difference was found ($p > 0,05$), immediately after the end of the test and 5 minutes after the end of the test ($p < 0,05$). In the present study, the comparison of HR, Burnout duration and distance data in $NaHCO_3$ intake status showed that the performance after $NaHCO_3$ was more significant and there was a statistically significant difference between the intake ($p < 0,05$). In conclusion, in our study, it was tested that lactic acid values of $NaHCO_3$ group in lactic acid values were lower. From this point of view, we can say that the athletes taking $NaHCO_3$ can tolerate lactic acid and perform their performances more.

Key words: Cycling, Lactic Acid, Heart Rate

Introduction

Cycling is an Olympic sport for all ages. Its popularity is rapidly increasing and cycling is being used for different purposes almost everywhere in the world. In our country, professional road and mountain bike races are rapidly gaining importance. Due to road and mountain bike sports contains high intensity, it plays a major role in improving the aerobic and anaerobic capacities of elite athletes. At the same time, it requires a high level of motoric properties such as force, flexibility, speed and endurance. For this reason, elite mountain bike athletes, as in every sports branch, should apply and organize their annual training programs, yearly, monthly, weekly and daily according to the targeted competition. Cycling training which is exercised approximately 6 days a week, should be supported with nutrition and rest. Race times can vary from approximately 80 to 130 minutes and the average Pulse values during the competition were observed to be 150-200 beats/min (1). Mountain biking has very high values in terms of intensity and force. In the training program which is prepared by considering many data, pulse values, lactic acid, maxVo2, watt values come to the forefront. In high-density mountain biking, anaerobic capacity and explosive force are very important. The anaerobic-glycolysis system is widely used during the competition (2,3,4). The energy produced in this system leads to the formation of lactic acid, since ATP molecules are not completely broken into pieces (4,5,6). Lactic acid creates a burning sensation in the muscles (2,5,6). Lactic acid, which occurs in high-intensity exercises, accumulates in the muscles and lowers the pH value in the cell and blood and makes muscle contraction difficult (7). There are several ways to absorb the lactic acid. Some of these are found in muscle fibrils and include protein, phosphate, bicarbonate, amino acid and peptide (8). The bicarbonate ion is known as a natural nutrient that forms acid-base balance in the body. In intensive exercises, 15–18% of the lactic acid tolerance capacity depends on the bicarbonate system (9). When the bicarbonate is taken from the outside before the exercise, such effects as delaying fatigue and increasing the performance were observed on the athletes. Shortly, bicarbonate is food taken in order to increase the performance of the athlete (10).

The aim of this study is to investigate the effect of sodium bicarbonate intake on lactic acid, heart rate and aerobic performance in elite mountain cyclists.

Material and Method

Ten licensed cyclists participated in the study. The ages of the cyclists are between 20–23 years. Personal information and findings obtained during and after the study will be kept strictly confidential. "Informed consent form" was obtained from athletes willing to participate voluntarily. Permission required for the study was obtained from the ethics committee of Süleyman Demirel University.

Body Weight Measurement: Weight measurement was weighed with SECA brand electronic scales with a sensitivity of 0,5 kg, athletes wearing only shorts and t-shirts with bare feet.

Height Measurement: Height measured with SECA brand device with bare feet.

Maximum Heart Rate Measurement: Heart rate is done with POLAR brand pulse clock and maximum pulse values after the test were checked and recorded.

Lactic Acid (LA) and Conconi Tests (Increased Aerobic Test): To see the athletes' lactate levels, Monark brand Ergomedic 839 E model bicycle ergometer and aerobic bicycle ergometer test was applied. Lactate measurements were made from the middle fingertip with the Lactate Scout device. Before the test, the lactate values were taken from the athletes at rest. The test was then started at 50 watts, and the test was continued by increasing 50 watts every 2 minutes. The test continued until the athlete was able to continue. Lactate acid measurement was performed immediately after the test and 5 minutes after the test, the values were noted. Second tests were performed 48 hours after the first test.

Administration of Sodium Bicarbonate to Athletes: In the study, 0,3 g/kg body weight dosage $NaHCO_3$ substance was given to athletes orally by mixing with 500 ml of juice 2 hours before the test.

Data Analysis: Demographic characteristics of the cyclists were summarized by descriptive statistics with minimum, maximum, x^{-} (Arithmetic Mean) and SD (Standard Deviation). In this study, the data obtained from the mentioned lactic acid were analyzed by repeated measures ANOVA technique in factorial order. In the study, two levels were analyzed as group factors before and after taking bicarbonate, and the time factor was analyzed in three levels: pre-test, just after the test and 5 minutes after the test. In order to determine the difference between the athletes before and after the test, "Paired test within the group" was applied. The significance level was evaluated according to the "0,05" importance level.

Findings

Table 1. Descriptive Statistical Analysis of Demographic Information of Cyclists

	Minimum	Maximum	$\bar{x}$	Sd
Age (years)	20,00	23,00	21,50	1,04
Height (cm)	168,00	182,00	175,50	4,63
Body Weight (kg)	60,00	82,00	69,00	9,16
Sport age (years)	5,00	10,00	7,83	1,94
BMI (kg/m^2)	19,80	26,50	22,35	2,36

Table 2. Results of Multiple Comparison Analysis of LA Values before and after Taking $NaHCO_3$

	$NaHCO_3$ Intake Times	LA Intake Times	x̄	Sd	F	p
LA (mmol)	$NaHCO_3^-$	Before Test	2,07	,42	87,488	,000*
		Immediately After Testing	12,82	2,49		
		5 min After Testing	9,80	1,96		
	$NaHCO_3^+$	Before Test	2,14	,26	53,153	,000*
		Immediately After Testing	11,06	2,73		
		5 min After Testing	8,20	2,46		

*p < 0,05

Table 3. Comparison of LA Values before and after Taking $NaHCO_3$

	LA Intake Times	$NaHCO_3$ Take Situations	x̄	Sd	t	p
LA (mmol)	Before Test	$NaHCO_3$–	2,07	,42	-,539	,613
		$NaHCO_3$+	2,14	,26		
	Immediately After Testing	$NaHCO_3$–	12,82	2,49	5,549	,003*
		$NaHCO_3$+	11,06	2,73		
	5 min After Testing	$NaHCO_3$–	9,80	1,96	4,532	,006*
		$NaHCO_3$+	8,20	2,46		

*p < 0,05

Table 4. Comparison of Maximum HR, Burnout Time and Distance Traveled Values before and after Taking $NaHCO_3$

	$NaHCO_3$ Take Situations	x̄	Sd	t	p
Maximum Heart Rate (volum/min)	$NaHCO_3^-$	187	11,52	-4,031	,010*
	$NaHCO_3^+$	192,83	10,6		
Burnout time (min)	$NaHCO_3^-$	11	1	-5,850	,002*
	$NaHCO_3^+$	12,23	1,41		
Distance traveled (km)	$NaHCO_3^-$	6,9	,53	-7,008	,001*
	$NaHCO_3^+$	7,5	,71		

*p < 0,05

Discussion

Multiple comparison analysis of the LA values before and after $NaHCO_3$ intake showed a statistically significant difference at both times ($p < 0,05$). However, after taking $NaHCO_3$, LA values decreased more significantly. Looking at the results of the comparison analysis of the $NaHCO_3$ uptake status of the LA values before and after $NaHCO_3$ intake, while there was no significant difference before the test ($p > 0,05$), a significant difference was found immediately after the end of the test and 5 minutes after the end of the test ($p < 0,05$). After increased loading exercise, faster lactic acid tolerance was observed in the group receiving $NaHCO_3$ immediately after the test and 5 minutes after the test. In our study, it was concluded that lactic acid levels were higher in persons receiving $NaHCO_3$ dietary supplementation and were in the same direction as other studies in the literature.

Cicioglu et al. (10) in the study of the effects of $NaHCO_3$ taken at different doses with 125% of VO2 Max supramaximal exercise performance and blood pH, La and HC03 - In all three trials, placebo (1,92 ± 1,09 mmol), D1 (1,5 ± 0,30 mmol), and D2 (1,83 ± 1) in lactic acid (La) values before exercise (placebo-D1-D2) 0,98 mmol/L) they did not find a significant difference in the study ($p > 0,01$). In this study, to examine the LA buffering of bicarbonate, the amount of La at the end of the placebo trial was compared with the amount of La at the same time as the blood taken during the trials equal to the end of the placebo trial during the D1 and D2 trials and the placebo La value at this time was 11,28 ± 2,15 mmol/L, D1 value was 9,62 ± 1,40 mmol/L and D2 value was determined as 11,01 ± 2,39 mmol/L. Although there was no statistically significant difference between the measurements ($p > 0,01$), the D1 trial was reported to be 1,66 mmol/L lower than the placebo trial. It has been reported that alkaline substances taken before anaerobic exercise will increase the alcoholysis in the indoor environment and will help the excretion of La from the working muscles and thus delay fatigue and increase performance (11,12,13,14). The lowest amount of HLa after exercise was found to be 11,96 ± 2,03 mmol/L in the placebo group, 16,54 ± 1,62 mmol/L in the D1 trial and 15,96 ± 3,05 mmol/L in the D2 trial (10). In this study, the increase in blood La concentration in exercise with bicarbonate intake, similar to some research done on this subject, while in some studies in alkalytic conditions blood $NaHCO_3$, despite the significant increase in muscle and blood pH values, and it shows that blood and muscle La values are in contrast with the results that there is no difference between bicarbonate and placebo trials (15,16).

Turna et al. (17) reported that as a result of comparison in pre and post-test values resting and maximal lactate level of athletes, differences were found to be statistically significant ($p < 0.05$). In the study of Koca et al. (18) reported that $NaHCO_3$ reduces blood lactate levels of individuals, but does not have an effect on lactate levels at different heights. There is a decrease in bicarbonate levels in the body during exercise compared to the severity of exercise, and this level returns back within 3-5 minutes following the end of exercise (19). In other words, prolonging the duration of exercise at the maximum intensity or delaying the occurrence of fatigue is in a sense delaying the reduction of $NaHCO_3$ levels in the body during exercise. In other researches, the effect of bicarbonate on short-term exercise was examined by giving $NaHCO_3$ at doses between 100 mg/kg and 300 mg/kg to active athletes in different branches. Gao et al. (11), in a study on swimmers; While $NaHCO_3$ has a positive effect on athletes' performance, other researchers have shown a similar effects on cyclists, rowers and 400 m runners (20,21,22). The researchers suggest that $NaHCO_3$ has a positive effect on short-term intensity by removing H^+ from the working tissue, lowering the intercellular Ph level and preventing excessive fatigue. Therefore, additional $NaHCO_3$ decreases the increased level of lactate in the blood, which adversely affects the athlete's performance. Similarly, Kozak et al. (23) found that $NaHCO_3$ had no effect on athletes' performance in trained cyclists living at an altitude of 2957 m. Blood lactate levels in untrained individuals vary between 9-12 mmol/L, while in trained individuals these values may increase to 12-22 mmol/L (24).

As a result of the present study, $M_{ax}HR$, burnout time, and distance traveled in $NaHCO_3$ intake cases, the performance after taking $NaHCO_3$ was found to be more significant and there was a statistically significant difference between intake ($p < 0,05$).

Ostariz et al. (25) in the study conducted on cyclists have determined resting pulses 58 ± 8 before the race and 86 ± 11 beats/min after the race. Campos et al. (26) in the similar study, have determined resting pulses HRR (bpm) 41,9 ± 12,8 beats / min. Stapelfeldt et al. (27) found that the number of heart beats they found to be relatively stable during the race was 177 ± 6. Robinson et al. (28), it was determined as 169,9 ± 38,8 watts in the pre-test and 192,9 ± 39,09 watts in the post-test in the working group. Senel et al. (29), the resting pulse values of the subjects were found to be 58,85 ± 6,41 beats/min, systolic blood pressures were 93,71 ± 10,57 mmHg and diastole blood pressures were 66,71 ± 7,67 mmHg.

Cruz et al. (30) in their study found that the maximal pulse values of the subjects were 179,75 ± 5,18 beats/min between 6-8 hours in the morning, while the maximal pulse values were 181,25 ± 8,71 beats/min in the evening between 6-8 hours. When compared with the literature, the values of the elite mountain cyclists in our study are similar.

Laursen et al. (31), in their study named interval training program optimization, have examined 4 groups of highly trained endurance cyclists. 1st Group had 8 intervals at 60% of intensity, 2nd Group had 8 intervals at 65% of intensity, 3th Group observed a pulse recovery time of 4,5 minutes in a high-intensity test at 175% intensity, 30 seconds, 12 repetitions. The fourth group is the control group which regularly applies low-intensity basic training programs. M_{ax}HR, G1, and G2 were 194 ± 14, G3 was 193 ± 7, and G4 was 189 ± 8, respectively. The reason for the similarity in M_{ax}HR in this study can be explained as the high value of M_{ax}HR depending on the training load applied in the study.

Results

In conclusion, in our study, it is found that Lactic Acid values of the group receiving $NaHCO_3$ have lower Lactic Acid values. Based on this, we can say that athletes taking $NaHCO_3$ tolerate Lactic Acid and can perform their performances more. The average burnout time of athletes receiving $NaHCO_3$ is 1: 23 min longer. In our study, we can suggest increase the number of cylists into more groups and examining the effects of $NaHCO_3$ in more detail. In order to observe gender differences, we recommend that women athletes be included in the study. We think that the lactic acid levels will be monitored during the loading and the anaerobic threshold will be determined and the athlete will contribute to the performance development. The post-training effects of $NaHCO_3$ can also be examined. Within the scope of this information, we think that it will be beneficial for Turkish cycling athletes to increase their performance and gain success with training and test programs implemented in longer periods. We hope that the results of the data obtained in our research will shed light on future studies in this field.

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