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CLINICAL RESEACRH

The Effect of Sports Drinks to Biochemical Signs on Delayed Onset Muscle Soreness (DOMS) in Dehydrated Individuals Due to Eccentric Exercise

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Introduction

The research was conducted on 24 healthy male subjects between the age of 20 and 30, who has not practiced any sports before, who has not taken part in any strength exercises in the past 3 months, and who does not smoke and use any medicine constantly such as antidepressants and diuretics which cause dehydration. No subjects below 18 were included in the study. The subjects were divided into two groups: the experiment group, who drink sports drink (n = 12), and the control group who drink water (n = 12) during the exercise.

In this study, the subjects were kept in sauna to enable dehydration, then they were given 30 minutes eccentric exercise training, and the effects of sports drinks on the Delayed Onset Muscle Soreness (DOMS) symptoms which were expected to develop were searched.

Ideal temperature in the sauna was kept between 90 and 95 degrees and all the subjects went into the sauna at this heat. The subjects in the sauna perspired in a position sitting on the middle bench and the subjects were not asked to make any physical activity in the sauna cabin.

Before and after the sauna, the weights of the subjects were controlled and the subjects who lost 2% of their weight were considered as dehydrated and they were given eccentric exercise. The control group members participated in the study by knowing that they were the control group and they were informed that they would have been given water as a liquid throughout the study. The subjects in the experiment group took only sports drink during the study. Before the sauna, for all the subjects, anthropometric measurements were made, arterial blood pressures were found, and in addition their blood samples were collected. The weights of all the subjects were measured with a digital weighting machine (± 50 gr.) in the morning and their heights were also measured in the morning. Blood samples were taken by sterilised green topped injector, as 5 ml, from their antecubital veins. The control group made eccentric exercise after sauna and they were given only water at that stage. After the exercise, the experiment group was given a sports drink which is sold in the market.

In that study, an isotonic sports drink, whose bottle is 500 ml. and which is largely consumed in the market was used. In that sports drink, there is no caffeine. In an amount of 500 ml of the sport drink, there is 120 kcal energy, 0 gr. protein, 0 gr. fat, 28 gr. carbohydrate, 260 mgr. sodium, and 30,5 mgr. potassium.

The exercise was realised for a total of 30 minutes in the step machine where, at a 90 degrees movement width, the knee joint would come to 90 degrees of flexion from 180 degrees of full extension. During the exercise, the Polar F4 Hearth Rate Monitor Watch, with a target pulse beep and visual alert, was placed on the arms of the subjects and the subjects were ensured to finalise the first 15 minutes of the exercise at an upper pulse limit of 130, and the second 15 minutes with an upper pulse limit of 150. Thus, all the subjects were

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ensured to conduct the exercises at the same pulse levels. Before starting with the exercise, the subjects were warmed up for 3 minutes in the bicycle ergo meter without applying any resistance and then they were started with the exercise.

During the exercise, to measure the pulse OwnCal® Polar F4 Hearth Rate Monitor Watch and was used. The step machine was the **RUNMILL TWIST & STEP**.

The subjects were given a total of 750 ml. water or sports drink: For the first time 250 ml. during the 10-15 minutes of resting period right after the sauna; and 250 ml. in each 15 minutes during the exercise. Blood pressures of the subjects were also checked once in 15 minutes. 5 ml. venous blood samples were collected right after the exercise and after 24, 48, 72 and 96 hours. The collected blood samples were stored in special biochemistry tubes; paying attention to the cold chain, the plasmas obtained after applying centrifuge were sent to a biochemistry centre; the samples were analysed there and the results obtained were carefully noted according to the dates.

Data Analysis

The data analysis was made with SPSS 11.5 software. Data were expressed as ± standard deviation. For the comparison of the repeated LDH measurements, the Repeated Measures Analysis of Variance was used. To examine the sources of differences due to time in the LDH measurements, Bonferroni multiple comparison test was used.

Results

In our study, 24 healthy male individuals were included. Special attention was given to the point that none of the subjects had been involved in sports professionally. The subjects were divided into two groups (control and experiment) with a draw.

The average age of the experiment group and control group was found as 23.6 and 24.8 respectively. The age range of the subjects in the experiment group was changing between 20 and 30, and that of the control group was changing between 21 and 29. No statistically significant difference between the age status of the groups was seen. This is demonstrated in the Table 1.1.

The average tallness of the experiment group was found as 174.5 cm and that of the control group was found as 173 cm. The tallness of the subjects in the experiment group ranged between 168 and 181 cm, and that of the control group subjects ranged between 167 and 181 cm. No statistically significant difference between the groups in terms of tallness was seen. This is demonstrated in the Table 1.2.

The weight of the experiment group, which was 7.82 kg before the sauna, decreased to 70.32 after the sauna and that of the control group, which was 70.98 before the sauna, decreased to 69.33 after the sauna. This is demonstrated in the Table 1.3.

When the weight loss of the experiment and the control groups are considered, it is seen that the subjects in both groups had a weight loss of 2%. This means that all the subjects both in the experiment group and in the control group became dehydrated.

Significant increase was observed in the CK measurements checked in the blood samples taken

Table 1.1: Age status of the control and experiment groups.

Groups	No	Average	Std. Deviation	Mean	Minimum	Maximum
Experiment Group	12	23,6667	2,77434	23,0000	20,00	30,00
Control Group	12	24,8333	2,51661	24,5000	21,00	29,00
Total	24	24,2500	2,65805	24,0000	20,00	30,00

Table 1.2: The tallness status of the experiment and control groups.

GR Groups	No	Average	Std. Deviation	Mean	Minimum	Maximum
Experiment Group	12	174,5000	4,12311	175,5000	168,00	181,00
Control Group	12	173,0000	4,22116	173,0000	167,00	181,00
Total	24	173,7500	4,15200	173,5000	167,00	181,00

Table 1.3: Weight status of the control and experiment groups before and after the sauna.

	Groups	N	Average	Std. Deviation	Mean	Minimum	Maximum
SAUNA 0	Experiment Group	12	71,8250	6,99118	72,4500	60,20	81,00
	Control Group	12	70,9833	7,92612	71,1000	59,90	83,10
	Total	24	71,4042	7,32165	72,4500	59,90	83,10
SAUNA 1	Experiment Group	12	70,3250	6,90798	70,9000	58,80	78,60
	Control Group	12	69,3333	7,86087	69,3000	58,20	81,50
	Total	24	69,8292	7,25483	70,9000	58,20	81,50

Table 2.1: CK status of the experiment and control groups before and after the exercise.

GROUPS		N	Average	Std. Deviation	Median	Minimum	Maximum
CK_EO	Experiment group	12	75,0000	14,63495	77,0000	53,00	98,00
	Control group	12	72,0000	12,34357	70,5000	56,00	98,00
	Total	24	73,5000	13,32862	73,0000	53,00	98,00
CK_ES	Experiment group	12	122,4167	17,29665	126,0000	94,00	146,00
	Control group	12	140,3333	29,44744	132,5000	98,00	197,00
	Total	24	131,3750	25,32882	128,0000	94,00	197,00
CK24	Experiment group	12	154,9167	26,52429	157,0000	102,00	197,00
	Control group	12	178,0000	18,00505	180,0000	133,00	198,00
	Total	24	166,4583	25,11016	176,0000	102,00	198,00
CK48	Experiment group	12	181,6667	15,43510	182,0000	156,00	201,00
	Control group	12	183,8333	16,29742	185,0000	141,00	199,00
	Total	24	182,7500	15,56264	184,0000	141,00	201,00
CK72	Experiment group	12	167,0833	16,62123	171,0000	138,00	189,00
	Control group	12	171,6667	14,27861	174,5000	145,00	190,00
	Total	24	169,3750	15,33343	173,0000	138,00	190,00
CK96	Experiment group	12	123,2500	29,71723	132,0000	69,00	159,00
	Control group	12	144,7500	30,04277	147,0000	89,00	177,00
	Total	24	134,0000	31,21872	137,5000	69,00	177,00

EO: before exercise; ES: after exercise

before the exercise, right after the exercise and at the 24th, 48th, 72nd and 96th hours. When this significant increase is statistically evaluated due to time, without considering the effect of the experiment and control groups, significant difference ($p < 0.001$) was observed between the CK measurements (conducted after the 24th, 48th, 72nd and 96th hours). This is shown in the Table 2.1.

The CK measurements conducted due to time in the experiment group showed significance difference ($p < 0.001$). The difference between the CK measurements before the exercise and those for all following times was significant. In the CK measurements, increase until the 48th hour and after that linear decrease was observed. In addition, the difference between the measurements after the exercise and those at the 24th, 48th and 72nd hours was found significant. The difference between the CK measurements of 24th hour and that of 48th hour was also significant. The difference between the CK measurements of 96th and 72nd hour and the CK measurements of the 48th jour was also statistically significant. The CK measurement of the 48th hour was higher compared to the other two measurement times. These findings has been consistently reported in the references 28, 29, 30, 31, 32, 33. Finally, the difference between the CK measurements of 72nd and 96th hours was also found significant and this was shown in the Table 2.2.

The CK measurements conducted due to time in the control group showed significant difference ($p < 0.001$). The difference between the measurements before the exercise and those for all following measurement times was significant. In the CK measurements, increase until the 48th hour and decrease after that was observed. In addition, the difference between the measurements after the exercise and those at the 24th and 48th hours was also significant. The CK measurements of the 24th hour were significantly lower than these two measurement times. The difference between the CK measurements of the 48th hour and those of the 96th hour was also statistically significant. The CK measurement of the 96th hour was found significantly lower than that of the 48th hour and this is shown in the Table 2.3.

In the Table 2.4., the illustrative statistics regarding the percentage change of the CK levels of 48th and 72nd hours compared to those before the exercise are given. Both percentage change measurements are found similar for the experiment and control group.

Discussion

Exercise-induced muscle soreness can be classified as either acute onset or delayed onset. Acute onset muscle soreness occurs during exercise and may lastup to 4 to 6 hours before subsiding [1-7]. Delayed Onset Muscle Soreness (DOMS) has onset 8 to 24 hours postexercise, with soreness peaking 24 to 48 hours postexercise [8-13]. The etiology of DOMS has been the topic of numerous studies, from which several theories have evolved Despite differences in theories, the following factors have been documented: 1. Strenuous activity especially eccentric exercise causes injury or traumato the muscle, its musculotendinous junction, or both [8-11,14,15]. 2. Injury and/or trauma initiates an inflammatory response resulting in muscles feeling painful and swollen 3. Pain

Table 2.2: CK measurements conducted due to time in the experiment group.

(I) CK	(J) CK	Average Change (I-J)	Std. error	Sig.[a]	95% Confidence Interval for Difference	
					Lower level	Upper level
1	2	-57,875*	4,184	,000	-71,644	-44,106
	3	-92,958*	3,983	,000	-106,065	-79,852
	4	-109,250*	3,949	,000	-122,244	-96,256
	5	-95,875*	4,072	,000	-109,275	-82,475
	6	-60,500*	6,074	,000	-80,490	-40,510
2	1	57,875*	4,184	,000	44,106	71,644
	3	-35,083*	4,868	,000	-51,103	-19,064
	4	-51,375*	5,299	,000	-68,813	-33,937
	5	-38,000*	5,839	,000	-57,216	-18,784
	6	-2,625	7,288	1,000	-26,610	21,360
3	1	92,958*	3,983	,000	79,852	106,065
	2	35,083*	4,868	,000	19,064	51,103
	4	-16,292*	3,455	,002	-27,661	-4,922
	5	-2,917*	4,766	1,000	-18,600	12,767
	6	32,458*	7,076	,002	9,172	55,745
4	1	109,250*	3,949	,000	96,256	122,244
	2	51,375*	5,299	,000	33,937	68,813
	3	16,292*	3,455	,002	4,922	27,661
	5	13,375*	2,797	,001	4,170	22,580
	6	48,750*	6,227	,000	28,258	69,242
5	1	95,875*	4,072	,000	82,475	109,275
	2	38,000*	5,839	,000	18,784	57,216
	3	2,917*	4,766	1,000	-12,767	18,600
	4	-13,375*	2,797	,001	-22,580	-4,170
	6	35,375*	6,397	,000	14,322	56,428
6	1	60,500*	6,074	,000	40,510	80,490
	2	2,625*	7,288	1,000	-21,360	26,610
	3	-32,458*	7,076	,002	-55,745	-9,172
	4	-48,750*	6,227	,000	-69,242	-28,258
	5	-35,375*	6,397	,000	-56,428	-14,322

occurrence is delayed approximately8 hours postactivity and graduallyincreases, peaking 24 to 48 hours postexercise before gradually subsiding to preexercise levels 4. Trauma results in significantly increasedlevels of muscle proteins and other breakdown products of muscle and collagen in the blood and/or urine (like; creatine kinase, lactat dehydrogenase,...) [16-18].

The signs and symptoms of DOMS are attributed to subcellular alterations of the sarcolemma, or phospholipid membrane, as a result of skeletal muscle microdamage [19-22]. The sarcolemma loses its ability to retain potassium, creatine kinase, and myoglobin, which are released into the extracellular fluid, plasma, and urine Efflux of intramuscular ions and proteins leads to increased osmolarity of the extracellular fluid and fluid shifts out of the cell [3,7,10,16,23-26].

During dehydration, plasma hyperosmolarity is exacerbated as water is redistributed from the intracellular to the extracellular compartments of skeletal muscle in an attempt to maintain normal blood osmolarity. Muscle proteins affected most by dehydration are those involved in electrolyte distribution across the sarcolemma (ie, sodium-potassium and calcium adenosine triphosphatases), calcium release and reuptake by the sarcoplasmic reticulum, and components of the mitochondrial respiratory chain

Table 2.3: CK measurements conducted due to time in the control group.

(I) CK	(J) CK	Average Change (I-J)	Std. error	Sig.[a]	95% Confidence Interval for Difference	
					Lower limit	Upper limit
1	2	-68,333*	7,462	,000	-96,155	-40,511
	3	-106,000*	5,351	,000	-125,951	-86,049
	4	-111,833*	5,036	,000	-130,609	-93,058
	5	-99,667*	4,233	,000	-115,447	-83,887
	6	-72,750*	9,275	,000	-107,328	-38,172
2	1	68,333*	7,462	,000	40,511	96,155
	3	-37,667*	8,016	,010	-67,554	-7,779
	4	-43,500*	8,678	,006	-75,855	-11,145
	5	-31,333	8,923	,073	-64,602	1,936
	6	-4,417	11,122	1,000	-45,881	37,048
3	1	106,000*	5,351	,000	86,049	125,951
	2	37,667*	8,016	,010	7,779	67,554
	4	-5,833	1,628	,064	-11,901	,235
	5	6,333	4,608	1,000	-10,846	23,513
	6	33,250	9,589	,079	-2,502	69,002
4	1	111,833*	5,036	,000	93,058	130,609
	2	43,500*	8,678	,006	11,145	75,855
	3	5,833	1,628	,064	-,235	11,901
	5	12,167	4,167	,209	-3,368	27,701
	6	39,083*	9,110	,019	5,119	73,048
5	1	99,667*	4,233	,000	83,887	115,447
	2	31,333	8,923	,073	-1,936	64,602
	3	-6,333	4,608	1,000	-23,513	10,846
	4	-12,167	4,167	,209	-27,701	3,368
	6	26,917	9,568	,253	-8,757	62,590
6	1	72,750*	9,275	,000	38,172	107,328
	2	4,417	11,122	1,000	-37,048	45,881
	3	-33,250	9,589	,079	-69,002	2,502
	4	-39,083*	9,110	,019	-73,048	-5,119
	5	-26,917	9,568	,253	-62,590	8,757

Table 2.4: CK changes between the groups before the exercise and at the 48th and 72nd hours.

GROUPS		N	Average	Std. Deviation	Median	Minimum	Maximum
CK48_0	Experiment group	12	151,6049	58,52933	125,1652	92,47	251,79
	Control group	12	160,6982	41,60061	158,1220	92,13	225,00
	Total	24	156,1516	49,87609	151,5707	92,13	251,79
CK72_0	Experiment group	12	132,3346	59,72387	120,5231	60,22	252,83
	Control group	12	143,2336	36,65659	137,2866	88,76	205,36
	Total	24	137,7841	48,78071	133,3476	60,22	252,83

[17,27-30]. Cardiovascular compensatory mechanisms for thermoregulatory blood pooling in the skin determine tolerance to dehydration and exercise in the heat. Exercise performance decreases as less blood is available for perfusion of active skeletal muscle. Blood flow to exercising muscles is significantly reduced with dehydration due to reductions in blood pressure and perfusion pressure [1-6,23,31,32].

Structural changes occurred, evidenced by the significant increases in serum CK levels over time. The elevated levels of creatine kinase appear to be quantitative markers of muscle damage. Others have shown that muscle damage exists immediately after exercise, but several hours may pass before pain is felt, anddamage continues to increase for about 4 hours. Strength decreases result because of the reluctance to use sore muscles and from the loss of inherent force-producing capacity with in the muscle [9,10,16,27].

The mechanisms producing delayed muscle soreness are vaguely understood,making information concerning prevention and treatment scarce. Previous studies have tried to isolatespecific mechanisms while other studies have attempted to prevent and treat the symptoms [7,22,26,30,31]. We attempted to prevent and treat muscular soreness through the use of sport drinks at dehydrate persons.

As a result of this study, it is found that it does not affect the CK values, which is among the biochemical parameter of DOMS, if the dehydrated individuals, who make eccentric exercise, intake water or sports drinks during the exercise. As a result of the study, it was found that whether the dehydrated individuals making eccentric exercise take water or sports drink during the exercise did not create any difference on CK (Creatinine Kinase), which are among the biochemical parameters of DOMS (Delayed Onset Muscle Soreness).

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