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The effect of acute creatinine monohydrate loading on wingate test results in 18–21 years old male soccer players

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Studies indicate that ingested creatinine monohydrate (CrM) preparations may boost the supply of creatinine phosphate in muscle and enhance recovery after exercise. However there is still controversy on the effect of CrM replenishment on ergonomically measured anaerobic exercise tolerance.

The purpose of this study is to examine the effect of acute high dose CrM loading on anaerobic exercises like standing long jump (SLJ), standing vertical skip (SVS) and anaerobic wingate test (AWT). The study is a prospective, double blind, placebo controlled study. The study included 30 young male soccer players randomized to receive either 0.25 gr/kg/day CrM for 4 days (Group 1, 15 athletes, mean age 18.64±0.92 years, height 1.76±0.05 meter, weight 71±5 kg) or same dosage of maltodextrin as matching placebo (Group 2, 15 athletes, mean age 18.47±1.23 years, height 1.78±0.06 meter, weight 73±5 kg). Anaerobic exercise tolerance was measured before and after intervention.

In Group 1 (CrM group) treatment had no effect on SLJ, SVS parameters. It also had no effect on peak power and fatigue index of AWT. However CrM treatment significantly but slightly increased mean power (+4%), minimum power (+7%) and total work (+4%) parameters of AWT. Placebo treatment had no effect on any of these parameters. Lactic acid levels increased in both groups in response to exercise though post intervention lactic acid increase in Group 1 seemed slightly blunted.

The CrM supplements caused a significant but slight increase in anaerobic wingate test parameters of mean power, minimum power and total power.

Keywords: wingate test, creatine supplementation, ergogenic aids, anaerobic test, lactate

Fast recovery after an effort is essential for success in competitive sports like soccer in which exertion is done in bursts. It is known that muscle stores of adenosine triphosphate (ATP) are enough for a burst of activity of 4 to 5 seconds even in highly trained athletes (1). It is also known that though very fast replenishment of ATP can be

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done from the supplies of muscular creatinine phosphate (PCr) these supplies are also limited and can last for 10 to 12 seconds under maximal muscular exercise (33). In sum, maximal anaerobic power and capacity of an athlete depends on muscular ATP and PCr stores (10), muscular ATP regeneration rate, muscular glycogen stores, muscular fiber types and individual differences in lactic acid tolerance. Therefore endurance in and rapid recovery from a burst of activity crucially depends on the replenishment of the stores of ATP, which in turn depends on the supply and replenishment of PCr in the muscles (2, 15, 34). Whatever its limitation, the ATP-PCr energy system is the most important power source in burst activities (33, 35).

As anaerobic power is very important for explosive activities like sprint, long jump, high jump, its quality and if deficient its improvement with appropriate exercise programs is paramount (10). Studies indicate that creatinine preparations can be employed as ready for use source of energy, and can speed up recovery after an activity (20, 21). In other words, increasing muscle and liver stores of PCr can increase tolerance to short-term maximal muscle activity and enhance recovery after exertion (22, 27). Creatine is widely used for performance enhancement; it is not on the list of substances prohibited by the International Olympic Committee (17), which is one of the most important reasons for the extensive use.

This study was undertaken to examine the effect of these widely used, legal, purportedly performance booster products, creatinine monohydrate (CrM) preparations, on short-term maximal muscular activity in a prospective, double blind, placebo controlled trial.

Materials and Methods

Study population

The study population consisted of 30 soccer players aged between 18 to 21 years. The athletes were randomized into two groups of 15. Fifteen athletes in Group 1 or intervention group received 0.25 gr/kg/day CrM for 4 days (mean age 18.64±0.92 years, height 1.76±0.05 meter, weight 71±5 kg). Fifteen athletes in Group 2 or the control group received 0.25 gr/kg/day maltodextrin as matching placebo (mean age 18.47±1.23 years, height 1.78±0.06 meter, weight 73±5 kg). Athletes stopped using vitamins and other supplements for the duration of the study and were fit in the previous 15 days. No special diet was given for the duration of the study. The study was approved by the local ethics committee. No change in the training regimen was requested during the study period. All patients were treated in accordance with the requirements of Good Clinical and Laboratory Practice. The Declaration of Helsinki's recommendations for guiding physicians in biomedical research involving human subjects were followed.

Supplementation protocol

The athletes of Group 1 were given 0.25 g/kg/day CrM in 3 equal doses for 4 days. The athletes of Group 2 were given matching placebo of maltodextrin 0.25 g/kg/day in 4 equal doses for 4 days. All these study drugs were given as tablets with plenty of water.

Study design

After basal laboratory tests were completed the athletes were randomized to receive either CrM or the matching placebo for 4 days after which the laboratory tests were repeated.

Laboratory testing

The study was undertaken in the laboratory of Sports Physiology in the morning after a light breakfast. History taking and physical examination was done at the start of the trial and electrocardiography was recorded. Basal lactic acid levels were measured before warm-up and after a 5-minute warm-up on bicycle and stretching, standing long jump (SLJ), standing vertical skip (SVS) tests were done. After a 20 minute recovery anaerobic wingate test (AWT) was recorded. Blood lactic acid level was measured 5 minutes after the end of AWT.

Standing Long Jump was done from standing position. The subjects stand on the start-line. While the subjects take their hands backside, band their knees approximately to 90° and jump forward as long as possible. The measurement between the first landing point and the start-line was acceped SLJ. SLJ was the best of the 3 trials of long jumps after warm-up, measured in centimeters.

Standing Vertical Skip: The subject stand on the electronic jumpmeter platform. The hands were free throughout the test. Knee angular displacement was standardised, i.e. the subjects were required to bend their knees approximately to 90° while jumping as high as possible. SVS was the best of the 3 trials of vertical skips measured with an electronic jumpmeter (Jump-MD, Takei Company Ltd. Tokyo/JAPAN) in centimeters.

Anaerobic Wingate Test is a 30 second bicycle ergometric test in which the athlete pedals as fast as possible against a fixed load of 75 g/kg. For every turn of the pedal the bicycle advances 6 meters (3, 5, 12, 30) Tests were done on Monark bicycle ergometer (Monark 814E, Vorber-Sweden). The bicycle was calibrated between runs. Standard warm-up before testing was 5-minute cycling against 50W. Wingate test was done as described in Bar-Or O (5). However the recordings were taken at 1-second intervals not 5. The test bicycle seat was adjusted before every run, and the feet of the athletes were fixed to the pedals. The athletes were requested to turn the pedals, gradually increasing the number of revolution to 120 rpm after which the weight of 75 g/kg was suddenly loaded and the test commenced. The athlete was loudly encouraged to continue testing for 30 seconds and the test terminated. The athlete continued to cycle for 3 more minutes unloaded, to carry away accumulated muscular lactic acid. Post exercise lactic acid level was measured 5 minutes after the termination of the test.

The following parameters were collected from anaerobic wingate test; peak power (PP) (watt), mean power (MP) (watt), minimum power (MinP) (watt), total work (TW, the total work done in 30 minutes) (kg.m.joule), and fatigue index (%FI). The fatigue index is calculated as (peak power–minimum power)/(peak power)×100.

Lactic acid levels were measured from finger prick blood samples using sticks for Lactate-Pro measurement system (KDK Corporation, Kyoto 601, JAPAN).

Statistical analysis

The numerical values are given as mean ± standard deviation. Pre-test and post-test numerical variables were compared between groups with the use of the Paired Samples Student's t test, if assumptions of normality of distribution were not violated, in which case log transformed values were compared. Within groups, the ANOVA Test was used for comparison of values before and after ergogenic supplement. When a significant F-score resulted, a Fishers LSD post hoc test was determined to pair-wise differences. The p value <0.05 criterion was used for establishing statistical significance. Statistical analysis was carried out on Statistical Package for Social Sciences for Windows ver 10.0 (SPSS Inc, Chicago, III, USA).

Results

There was no significant difference between groups for age, height, pre test and post test weight (Table I). The results of SLJ, SVS and anaerobic wingate test parameters of groups are given on Table II. In Group 1 (CrM group) treatment had no effect on SLJ, SVS parameters. It also had no effect on peak power of AWT. However CrM treatment significantly but slightly increased mean power (+4%), minimum power (+7%) and total work (+4%) parameters and slightly decreased fatigue index of AWT. Placebo treatment had no effect on any of these parameters. Lactic acid levels increased in both groups in response to exercise though post intervention lactic acid increase in Group 1 seemed slightly blunted.

Table I

Anthropometric values of subjects before and after creatinin or placebo treatment (mean±SD)

	Age (years)	Height (cm)	Weight before (kg)	Weight after (kg)
Group 1 (n: 15)	18.64 ± 0.92	175.86 ± 4.72	70.66 ± 4.92	70.75 ± 5.20
Group 2 (n: 15)	18.47 ± 1.23	177.70 ± 5.75	72.87 ± 5.23	72.65 ± 5.12
P value	>0.05	>0.05	>0.05	>0.05

No significant differences between the groups.

Table II

Wingate test, standing long jump and standing vertical skip results of subjects before and after creatinin or placebo treatment (mean±SD)

	Group 1 (n: 15)		P value
	before	after	
Peak power (W)	837.25±113.98	846.94±101.29	p>0.05
Peak power (kg.m/s)	85.33±11.62	86.36±10.32	p>0.05
Mean power (W)	584.63±61.12	599.31±54.87	p<0.05
Mean power (kg.m/s)	59.57±6.23	61.30±6.04	p<0.05
Minimum power (W)	395.98±49.47	421.69±42.17	p<0.001
Minimum power (kg.m/s)	40.57±5.31	43.42±3.72	p=0.003
Total work (kg.m/s)	1789.4±186.84	1830.1±181.28	p<0.05
Total work (Joule)	17449.4±1832.3	17996.9±1777.8	p<0.05
Fatigue index (%)	52.45±5.1	49.72±5.14	p<0.05
SVS (cm)	55.42±5.53	53.33±5.26	p>0.05
SLJ (m)	2.40±0.14	2.44±0.17	p>0.05
Pre-test LA, ng/ml	1.88±0.62	1.96±0.63	p>0.05
Post-test LA, ng/ml	16.48±1.94	14.6±1.92	p<0.05
	Group 2 (n: 15)		P value
	before	after	
Peak power (W)	839.65±79.59	837.34±66.93	p>0.05
Peak power (kg.m/s)	85.62±8.12	85.38±6.83	p>0.05
Mean power (W)	583.82±45.11	588.59±55.77	p>0.05
Mean power (kg.m/s)	59.53±4.6	60.02±5.69	p>0.05
Minimum power (W)	397.09±48.71	387.17±38.70	p>0.05
Minimum power (kg.m/s)	40.48±4.97	39.99±4.13	p>0.05
Total work (kg.m/s)	1786.01±138.01	1800.61±170.6	p>0.05
Total work (Joule)	17514.1±1353.4	17657.8±1673.1	p>0.05
Fatigue index (%)	52.25±7.85	53.16±4.01	p>0.05
SVS (cm)	53.87±5.85	53.85±4.84	p>0.05
SLJ (m)	2.34±0.2	2.34±0.17	p>0.05
Pre-test LA, ng/ml	2.06±0.78	1.80±0.65	p>0.05
Post-test LA, ng/ml	16.82±2.26	16.70±2.54	p>0.05

SLJ: Standing Long Jump
SVS: Standing Vertical Skip
LA: Lactic acid

Discussion

Since Harris et al. (14) first reported a 26% increase in creatinine retention after 4 days of 30 g per day creatinine loading, interest in using creatinine for ergogenic aid has continued unabated. Different studies were done to assess the utility of using CrM to increase athletic performance (13, 18, 28) In studies that measured PCr stores, 3–6 days of 20–30-g/day creatinine supplementation increased total muscle stores of PCr. However studies examining the ergogenic effect of creatinine supplements reached different conclusions of no effect (4, 7, 9, 11, 26, 29) or positive effect (8, 19, 20, 23, 24, 31, 32) These discrepancies may be due to different study designs, differences in sample size, age, sex, physical fitness of the athletes, or the dose, duration, and manner of intake of creatinine supplements. Whether or not substantiated, there is a widespread belief in the usefulness of creatinine supplements among athletes. Meir (22) reported that 35.3% of the athletes using creatinine supplements believed that creatinine supplements increased endurance, caused faster recovery after a sprint (29.4%) or after training (23.5%).

In this study, 4 days of CrM loading caused a slight (4–7%) increase in some of the parameters of anaerobic wingate test compared to placebo. Additionally there was a slight but non-significant increase in PP (Fig. 1). The pre and post intervention tests were unchanged in the placebo group. These results seemed to confirm the hypothetical utility of CrM in athletes. Oral CrM may increase total body and muscle creatinine and thus increase tolerance to short-term high intensity exercise and speed recovery after exertion (6, 8, 18, 25, 26).

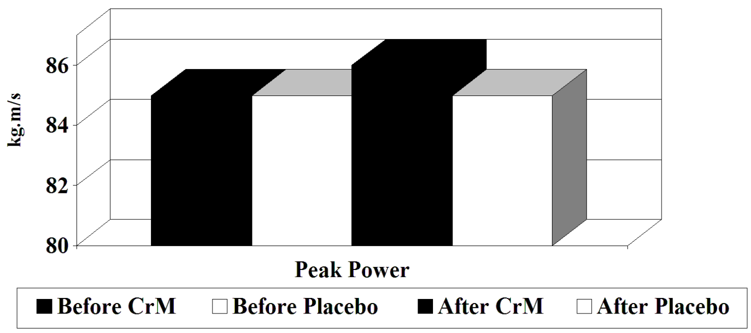

Fig. 1. Wingate peak power test results of athletes using creatine monohydrate and placebo group

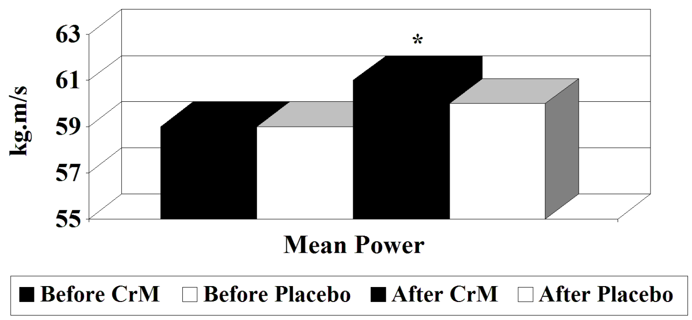

Fig. 2. Wingate mean power test results of athletes using creatine monohydrate and placebo group (*p<0.05)

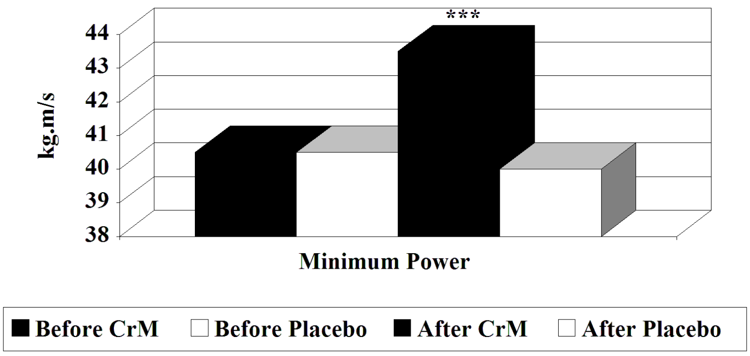

Fig. 3. Wingate minimum power test results of athletes using creatine monohydrate and placebo group (*p<0.001)

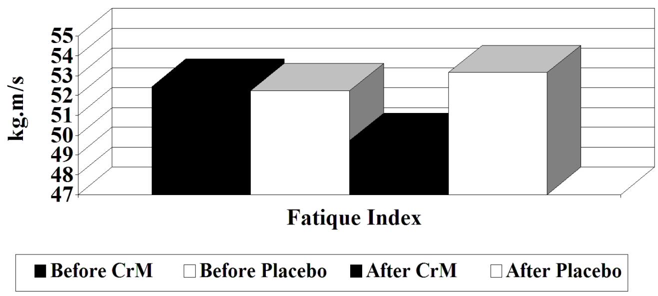

Fig. 4. Fatique index results of the wingate test of athletes using creatine monohydrate and placebo group

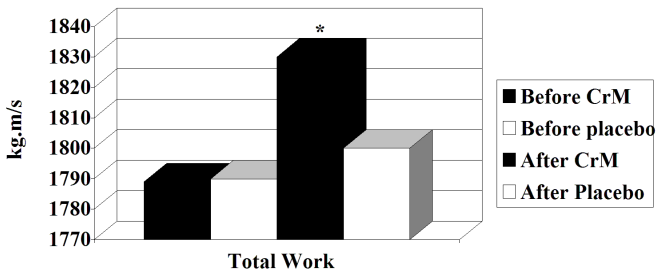

Fig. 5. Wingate total work test results of athletes using creatine monohydrate and placebo group (*p<0.05)

The slight increase in MP, MinP, TW (Figs 2, 3, 5, 6) and the slight decrease in FI% (Fig. 4) of AWT parameters seen in CrM supplement group may be due to the effect of supplements on PCr stores, which are recruited following the first 10 seconds of exercise when the stores of ATP are depleted and stores of PCr are used to replenish ATP stocks. However PP parameter in AWT depends on ATP stores which are not affected by the level of CrM stores. Similarly SLJ and SVS are not influenced by CrM supplements that also depended on ATP stores. However Stout et al. (28) reported that 5.25 g/day CrM supplementation increased SVS in soccer players. This discrepancy arose due to repeated nature of the vertical jumps in the aforementioned study. After 3 or 4 jumps muscular ATP stores were depleted and replenishment of ATP from PCr kicked in and the advantage of CrM supplements became apparent.

There also was a slight blunting in the increase of lactic acid in CrM supplement group. This may be due to delay in the formation of lactic acid in this group. PCr has an acid buffering ability, which represents 30% of the buffering capacity of the muscle. The increase in buffering capacity may increase the tolerance of muscle to higher levels of lactic acid, which in turn increase performance (16, 31). Additionally increased total PCr levels increase ATP synthesis rates and enhance recovery after repeated high levels of exercise like repeated sprints in soccer players (23).

It was concluded that CrM supplements caused a significant but slight increases in anaerobic wingate test parameters of mean power, minimum power and total power. Though the effect is small and may be felt negligible, in highly competitive athletic scene in which every millisecond or centimeter count, the slight edge that may be brought out by CrM cannot be disregarded.

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