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SHORT COMMUNICATION

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Effect of short-term creatine supplementation on renal responses in men

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Abstract There is an increasing utilisation of oral creatine (Cr) supplementation among athletes who hope to enhance their performance but it is not known if this ingestion has any detrimental effect on the kidney. Five healthy men ingested either a placebo or 20 g of creatine monohydrate per day for 5 consecutive days. Blood samples and urine collections were analysed for Cr and creatinine (Crn) determination after each experimental session. Total protein and albumin urine excretion rates were also determined. Oral Cr supplementation had a significant incremental impact on arterial content (3.7 fold) and urine excretion rate (90 fold) of this compound. In contrast, arterial and urine Crn values were not affected by the Cr ingestion. The glomerular filtration rate (Crn clearance) and the total protein and albumin excretion rates remained within the normal range. In conclusion, this investigation showed that short-term oral Cr supplementation does not appear to have any detrimental effect on the renal responses of healthy men.

Key words Creatine · creatinine · kidney

Introduction

Creatine (Cr) is a naturally occuring nitrogen compound found primarily in skeletal muscle. Its phosphorylated form plays a pivotal role in energy metabolism by supplying phosphate group to ADP to regenerate ATP. Recently, it has been shown that ingestion of 20–30 g Cr per day for several days can lead to an increase in human skeletal muscle total Cr and phosphorylcreatine (Balsom et al. 1994).

It has been suggested that a nitrogen-rich diet might itself induce chronic renal hyperfiltration and hyperfusion and thereby contribute to the functional and structural deterioration of the kidney (Brenner et al. 1982). Theoretically, the two amino and one carboxyle groups of creatine, as well as its high nitrogen content (32%), could add some strain on the kidney if taken in large excess.

The aim of the present study was therefore to investigate the effect of short-term oral Cr ingestion on the estimated glomerular filtration rate and the protein excretion rate.

Methods

Subjects and protocol

The experimental protocol was approved by the Ethics Committee of the Faculty of Medicine and all subjects gave informed written consent before participating in the study. Five male subjects took part in the present experiment. Their physical characteristics were as follows (mean and SD): age 25.1 ± 2.7 year; weight 82.4 ± 3.3 kg; height 180 ± 3 cm. Each subject was instructed for 5 consecutive days to ingest a total 20 g creatine monohydrate (Ultimate Nutrition Products, Inc, Plainville, USA) per day, distributed in 5 g doses Cr (mixed with 5 g of Gatorade powder, containing sucrose and dextrose) in the early morning, at noon, in the late afternoon and in the evening. Each dose was dissolved in warm water. During this period, the subjects were also instructed to remain on a similar protein diet. Two weeks apart the same protocol was repeated using 5 g doses of placebo (Gatorade powder).

After each five day session, the subjects reported to the laboratory with a 24 h urine collection. Blood samples were drawn from the femoral artery and assayed for Cr and creatinine, Crn (enzymatic colorimetric test PAP from Boehringer Mannheim, Germany). The same enzymatic test was used to determine Cr and Crn in urine. Total protein and albumin in urine were determined by a colorimetric test (Yatzidis 1977) and an immunological method (Metzmann 1985) (Turbiquant Albumin urine Behring), respec-

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Table 1 Plasma and urine contents in placebo and creatine supplementation conditions ($n = 5$), mean ± SD

	Placebo	Creatine supplementation
Creatine		
arterial ($\mu mol \cdot l^{-1}$)	74.0 ± 69.4	275.3 ± 213.5*
urine ($\mu mol \cdot min^{-1}$)	7.62 ± 4.57	682.5 ± 266.1*
clearance ($ml \cdot min^{-1}$)	13.5 ± 3.0	365.5 ± 87.0*
Creatinine		
arterial ($\mu mol \cdot l^{-1}$)	85.7 ± 15.0	92.8 ± 14.1
urine ($\mu mol \cdot min^{-1}$)	133.5 ± 25.6	142.3 ± 89.5
clearance ($ml \cdot min^{-1}$)	159 ± 19	165 ± 49
Proteins in urine		
total ($\mu g \cdot min^{-1}$)	39.4 ± 11.6	60.8 ± 12.3
albumin ($\mu g \cdot min^{-1}$)	8.0 ± 1.9	7.9 ± 0.6

* $P < 0.05$ between placebo and creatine supplementation

tively. The glomerular filtration rate was indirectly estimated by the Crn clearance (ratio of urine excretion to plasma concentration). The same calculation was applied to the Cr clearance.

Statistics

The statistical differences between placebo and Cr supplementation were estimated at a P level < 0.05 (two-tailed) using the Wilcoxon matched-pairs signed-ranks test.

Results

The 5 day period of Cr supplementation increased the arterial content by a mean 3.7 fold while the urine excretion rate increased by a mean 90 fold as compared to the placebo period (Table 1). The average clearance was enhanced 27 fold. On the contrary, neither the arterial Crn level and urine excretion rate nor the estimated glomerular filtration rate (Crn clerance) was affected by the oral Cr supplementation. In addition, Cr ingestion had no detrimental effect on the kidney protein excretion rates (Table 1).

Discussion

It has been reported that excess dietary protein (Tolins et al. 1995) and amino acid loading (Mogensen and Solling 1977; Coppo et al. 1993) are associated with renal hyperfiltration, vasodilation and inhibition of tubular protein reabsorption. These effects can induce proteinuria and progressive kidney impairments.

The present investigation demonstrates several important effects of Cr supplementation. Firstly, it has been observed that oral Cr supplementation had a profound impact on the arterial level of Cr, enhancing the penetration of this compound within the muscle compartment. Secondly, there was a massive urine excretion of the ingested Cr (about 60% of the oral load). When account is taken of the arterial content and the glomerulat filtration rate, this implies an important tubular secretion of Cr, an observation not previously described. Thirdly, the non-enzymatic reaction of muscle Cr to Crn was not modified by the large influx of Cr. It implies that normalization of urinary analyses still can be achieved using Crn values in conditions of Cr loading. Fourthly, the kidney reacted normally to the short-term ingestion of Cr. The estimated glomerular filtration rate and the urine excretion rate of total protein and plasma albumin remained within the normal range of a healthy population (Poortmans and Vanderstraeten 1994). No sign of hyperfiltration were observed under these conditions.

In conclusion, these results demonstrated that 5 consecutive days of oral ingestion of 20 g Cr per day does not appear to have any detrimental effect on the renal responses of healthy men.

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