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Urinary insulin-like growth factor-I measurement in an actual sport competition, an additional approach in laboratory antidoping tests

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Abstract

Background: The insulin-like growth factor hormone (IGF-I) is an important protein hormone under investigation with physical exercise and for doping detection. Urinary IGF-I level in fact represents a relevant measurement when the postexercise proteinuria is under analysis. To verify the IGF-I level variation in the circulation and in urinary excretion in the occasion of a competition, the plasma and urine IGF-I in athletes before and after an actual competitive event were measured.

Methods: Twenty well-trained cyclists took part in a competition (102 km) and concluded the intense physical exercise in approximately $2^{1/2}$ h. Urine and blood samples were collected from each athlete 10–20 min before and at the end of the competition. Plasma and urine total IGF-I (pIGF, uIGF), total urinary proteins (uPr), and creatinine (uCr) concentrations were measured.

Results: The uIGF [from 76.2±15.8 to 256.9±29.1 ng/l ($p<0.001$)], uPr [from 29.4±6.7 to 325.9±95.1 mg/l ($p<0.005$)], and uCr [from 6.3±1.0 to 10.0±0.8 mmol/l ($p<0.005$)] significantly increased. The pIGF was 262.6±14.3 and 247.3±11.8 μg/l before and end-exercise, respectively. A statistical correlation between uIGF and uPr was demonstrated ($p<0.001$). The pIGF/uIGF ratio was significantly ($p<0.05$) decreased comparing the end with before the competition.

Conclusions: The pIGF/uIGF significantly decreased at the end, compared with before the competition, suggesting a changed uIGF excretion. This increment appeared to be increased, although not significantly, considering the ratio with uCr.

Keywords: Urinary protein; Plasma/urine ratio; Glomerular filtration; Exercise; IGF excretion

1. Introduction

Protein excretion increment in urine collected after intense physical exercise is well documented [1].

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Many studies have shown that the kidney plays an important role in the metabolism of many proteins and small peptides which originate in the circulation. The kidney must also be taken into account in its ability to handle, synthesise, and secrete these molecules in the extracellular compartment [2].

Recently Uemasu et al. [3] investigated the existence of growth hormone (GH)/IGF-I system within the kidney, and observed that IGF-I extracted from the urine showed parallelism with circulating IGF-I. The administration of recombinant hGH (human growth hormone) caused a decrease in the urinary excretion of IGF-I. Uemasu's proposal is that this fact could depend on a decrease of free IGF-I glomerular filtration or on an increase of the tubular uptake of filtered IGF-I. A further aspect is the possibility that hGH, increased with physical exercise, could modify the renal function, including an increase of tubular phosphate reabsorption, gluconeogenesis, and tubular acid excretion [4,5].

Among the circulating peptide/protein hormones involved in organism adaptation to physical exercise, hGH and insulin-like growth factor I occupy an interesting role [6]. It might therefore be important to investigate, with regard to the exact origin of urinary IGF-I, whether urine levels represent only the filtration of small molecules. A locally generated renal IGF-I could also be considered. The measurement of this hormone might give useful results in understanding any role this molecule might have at a urinary level in clinical as well as in physiological applications. A further interesting application would be the possibility to collect biochemical laboratory data for antidoping aims. In fact, IGF-I can be related to hGH abuse, but also its direct employ cannot be excluded for illegal doping purposes in athletes.

For research purposes, analyses are frequently carried out on specimens collected from athletes not on the occasion of a competitive event, but when the performance and the conditions of the individuals are well standardised. However, more usually, blood and urine collection for analyses is routinely used in the care and study of the athletes' health condition and not for scientific research purposes. The aim of the present investigation was to study the effect of strenuous prolonged physical exercise, such as during competition, on the plasma and urinary IGF-I concentrations. Our intention was also to assess the relation of the measurements of this peptide hormone in plasma and in urine emphasising the actual competition effects, also taking into account that this is a condition usually happening in the course of an antidoping control. Taking into account this last aspect, the urinary concentrations of creatinine and total proteins in the same subjects, before and after the same actual competition, were also investigated.

2. Materials and methods

The study protocol was approved by the local University Ethics Committee. Informed consent was obtained from 20 male well-trained cyclists. They were professional athletes in a state of continuous training during the racing season.

The anthropometric parameters of the cyclists were age 17–18 years, weight 56–77 kg (average 65.3 kg), and height 158–189 cm (average 168.2 cm). This study was carried out during a mountain race (about 102 km). All studied cyclists had a 1350–1500 kcal meal (65% carbohydrates, 25% lipids, 10% proteins) 120–180 min before the competition. The competition took place late in the morning starting about midday and was concluded in approximately $2^{1/2}$ h. Samples of urine and blood were collected from each athlete 10–20 min before the start of the race. Blood was collected after they had been seated for 5 min, and urine was collected immediately afterwards. This procedure was also followed at the end of the competition. The subjects had been seated for more then 5 min when the postexercise samples were collected. Each cyclist confirmed that no drug had been taken after 8 p.m. the previous evening and that no special medical treatment was in act. Immediately after the end of the competition (end-exercise, no later than 10 min after the end of the race), each athlete reported to the mobile laboratory, and a second sample of urine and blood was collected.

At the end of the race, the weight of each cyclist was decreased by about 1.5 kg. During the race, the average fluid intake (sweet weak tea, 4%) of each athlete was approximately 600–1000 ml. The climatic temperature was about 15 °C, and it was raining heavily, therefore the fluid intake was less than usual.