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SHORT COMMUNICATION

EFFECT OF PROLONGED EXERCISE ON LIVER TRYPTOPHAN OXYGENASE ACTIVITY IN RAT

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Abstract. The purpose of the study was to investigate whether prolonged exercises influence the activity of liver tryptophan oxygenase. Hepatic tryptophan oxygenase activity was assessed in male Wistar rats after swimming for 4, 8, 12 or 16 h. Simultaneously blood corticosterone concentration was determined in blood plasma. After swimming for 4 or 8 h the enzyme activity was increased. More prolonged swimming sets caused enzyme activities below the control level. Enzyme activity alterations were concordant with changes in blood level of corticosterone ($r=0.537$, $p<0.01$). ***(Biol.Sport 22:29-33, 2005)***

Key words: Blood corticosterone - Central fatigue - Tryptophan metabolism

Introduction

Prolonged exercise increase the serum tryptophan concentration [1,14]. Increase of free unbound tryptophan in blood fascilitates the entry of this amino acid into the brain, particulary in combination with reduced blood level of branched-chain amino acids. This way the increased concentration of the tryptophan favours the serotonin formation in brain tissue [2,7]. The theory of central fatigue [11,14] assumes that the mentioned chain of event is important for changes in the brain causing decreased neuromuscular performance.

Besides synthesis of serotonin, tryptophan is precursor for several other metabolically essential compounds [13]. Tryptophan oxygenase (1.13.1.12) induces oxidative transformations of tryptophan which lead through several biochemical reaction to formation of kinurein and later of NAD^+ and $NADP^+$[3].

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Increased immunochemical titer of liver tryptophan oxygenase [5] as well as increased rate of incorporation of labelled amino acids into the apoenzyme of tryptophan oxygenase after administration of glucocorticoids evidence that glucocorticoids induce the synthesis of this enzyme [4]. Activity of tryptophan oxygenase increased when glucocorticoids were administered in physiological concentration or when secretion of glucocorticoids by adrenal cortex was stimulated [9].

The present study was aimed to establish the changes of tryptophan oxygenase during prolonged exercise. Simultaneously a possibility was tested whether the alterations in the enzyme activity are related to adrenocortical activity.

Material and Methods

Groups of 4 to 6 male Wistar rats (body weight of 180-240 g) swam for 4, 8, 12 and 16 h in water 32±1° C. The control group consisted of 15 sedentary rats of the same body weight and living in the same conditions. The rats were kept under constant conditions (light: dark regime 12 and 12 h), had free access to a standard laboratory diet (12-15% protein, 26-30% carbohydrates, 8-10% lipids, and 45-54% water), drinking water was given *ad libitum.*

Swimming experiments started 8.00 a.m. Immediately after swimming animals were submitted to ether inhalation. On the 2nd min of inhalation the animals were bleeded by the aorta puncture. The liver was excised and frozen in liquid nitrogen. Plasma was separated with centrifugation at +4°C. Both liver and plasma samples were stored at -20°C. Sedentary rats were bleeded simultaneously with experimental rats.

The activity of tryptophan 2,3-dioxygenase (1.13.1.11) was determined in the homogenate of hepatic tissue by the method of Knox and Auerbach [8]. The plasma level of corticosterone was determined by a fluorometry procedure after thin-layer chromatography on silica gel [10].

Statistic: The variance of results within a group and between the groups were assessed with the aid of ANOVA for repeated measurements together with Tukey-HSD post hoc procedure.

Results

After swimming for 4 or 8 h, corticosterone concentrations ($p<0.001$) and the enzyme activity ($p<0.05$) were significantly higher than in sedentary control rats (Fig. 1). After swimming for 12 h the hormone level and the enzyme activity did

not differ significantly from values in sedentary rats. After swimming for 16 h the corticosterone level was close to the values in sedentary controls, the enzyme activity was significantly ($p<0.05$) lower than in control rats. A significant correlation ($r=0.537$, $p<0.05$) was found between activity of the hepatic enzyme and blood corticosterone concentration.

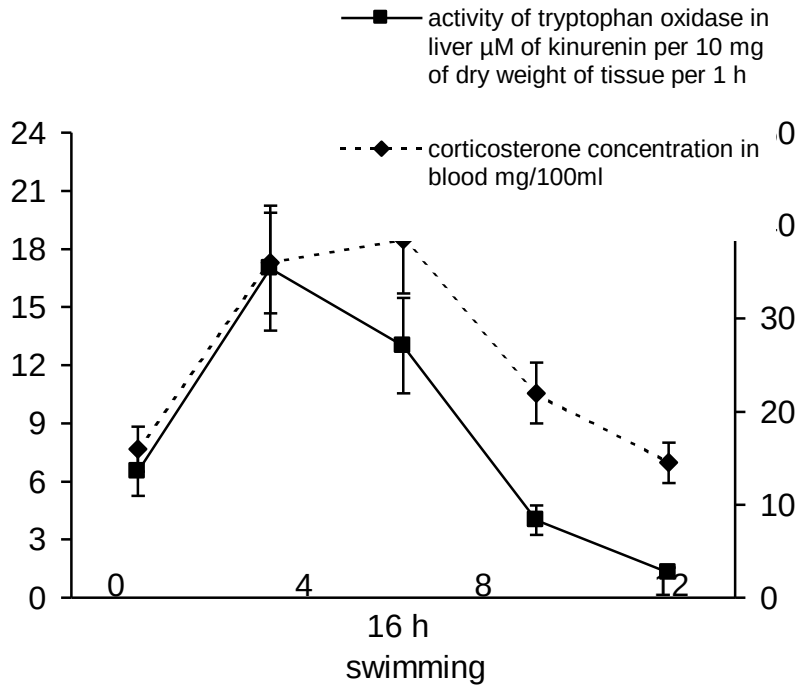

Fig. 1
Dynamics of blood plasma corticosterone and activity of tryptophan oxidase during prolonged swimming in rats

Discussion

The main result of the present study is biphasic changes in the activity of hepatic tryptophan oxygenase during prolonged exercise: swimming for 4 or 8 h increased, whereas swimming for 12 or 16 h decreased the activity of tryptophan oxygenase.

In accordance with previous results [10] Wistar rats are able to swimm in warm water (32°C) at least 16 h. Results of the present study confirmed the previous observation that during the period of prolonged swimming two phases of adrenocorticl activity appears: the increase during first hours of swimming is afterward substituted by decreased adrenocortical activity [12]. In the present experiment the swimming for 12 h ended 20.00 p.m., for 16 h 24.00 p.m. Thus the decrease blood corticosteron appeared despite the increase of blood corticosterone level in rats at night.

Convincing evidences has been obtained that glucocorticoids induce synthesis of tryptophan oxygenase in liver [4]. Accordingly it is possible to see the reason of increased activity of tryptophan oxygenase in increased rate of synthesis of enzyme molecules. This possibility is supported by facts that (1) physiologically induced changes in adrenocortical activity increase the synthesis of hepatic tryptophan oxygenase [9], (2) glucocorticoids results in increased enzyme activity and concentration within 2 to 5 h [6]. Thus, the exercise-induced increase in glucocorticoid output could influence the enzyme activity. Swimming for many hours provide sufficient time to produce an increased number of molecules of the enzyme. The increased enzyme activity disappeared together with the decrease in blood corticosterone concentration. Plausably, the increased enzyme activity may be maintained only with the aid of continuous inductory action of glucocorticoids.

Further research is necessary to clarify whether the changes in the activity of tryptophan oxygenase influence the tryptophan level in blood. Still it is possible to speculate, that increased tryptophan level during prolonged exercises [1,14] is related to the reduction of tryptophan utilization for its oxidative transformations. Therefore, the decrease of adrenocortical activity may favour tryptophan accumulation and, thereby, serotonin synthesis in brain tissue. This change is considered essential for the the mechanism of the central fatigue [11,14].

In conclusion, prolonged exercises induce biphasic changes in the activity of hepatic tryptophan oxygenase. These changes are concordant with initial increase and followed reduction in blood corticosterone concentration.

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