Serum Growth Hormone and Glucose Levels in Acute Exercise and in the Recovery Period in Athletes

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Abstract

Growth hormone exerts several metabolic effects, including effects on proteins, fats and carbohydrates. Among the many metabolic activities of GH, two contradictory actions were described: acute and early insulin-like activity and chronic and late anti-insulin like activity also called diabetogenic activity. A dramatic increase in plasma concentration of GH was found during endurance exercise, but its role during exercise is not well known. According to its metabolic effects a possible role of growth hormone may be in maintenance of glucose level during exercise. The aim of this study was to analyze dynamics of changes in GH and glucose levels during acute workload and in the recovery period, in a group of well trained athletes. All the subjects exercised for 30 minutes on cycle ergometer in sitting position (work intensity 50% of VO2 max, RPM 60/min). Serum GH concentrations were measured by IRMA (immunoradiometric assays) method in blood samples obtained at rest and 6-min intervals during exercise, and 15-min intervals during recovery period. Serum glucose levels were determined by standard enzymatic method glucose oxidase (GOD PAP) at the same intervals. There were no correlations between serum GH and glucose levels either during exercise or in the recovery period. There were no differences between glucose levels during exercise, so we can not exclude possible role of GH in glucose concentration maintenance.

KEY WORDS: serum growth hormone, glucose level, exercise, recovery period, athletes

Introduction

Growth hormone is a peptide hormone synthesized and secreted by the anterior segment of the pituitary gland. As a protein based hormone, GH is carried in the systemic circulation in the unbound or "free" state. Once in the systemic blood supply, GH is known to have varied effects on many different types of tissues (1). GH major function is growth promotion. In healthy adults GH exerts several metabolic effects, including effects on proteins, fats and carbohydrates. Among the many metabolic activities of GH, two contradictory actions were described: acute and early insulin-like activity and chronic and late anti-insulin like activity also called diabetogenic activity. Acute insulin-like effects include hypoglicemia, increased glucose and amino acid transport and metabolism, augmented protein synthesis, increased glycogenesis and heightened lipogenesis. These insulin-like effects are primarily seen in vitro or under special circumstances such as after hypophysectomy (2). GH's anti-insulin activities include hyperglycemia, hyperinsulinemia, increased lipolysis, reduced glucose transport, increased serum levels of non-esterified fatty acids, decreased glucose metabolism and insulin resistance. In order to explain these related, but opposite activities, as well as other multiple GH activities three hypotheses have been presented: a) the existence of multiple GH receptors (GHRs) b) the presence of multiple "active centers" in the GH molecule and c) the presence of small active GH fragments that result in the multiple activities of GH (2). It is well established that exercise affects circulating levels of various hormones, including growth hormone (GH). In both men and women, plasma GH concentration were found to increase dramatically during endurance exercise featuring an intensity of at least 40% of maximal aerobic power. There appears to be a direct relationship between exercise intensity and GH response (3). Not only does the exercise stimulus alter acute plasma hormone concentrations, but prolonged exercise training programs was found to change resting plasma levels (4). As with other hormones, training status may affect GH response to endurance exercise. Some studies showed athletes to demonstrate a blunted GH response to exercise compared to untrained subjects, even while exercising at equal relative intensities (5). The role of growth hormone during exercise is not well known. Most of exercise responsive hormones (for example glucocorticoides, thyroid hormones etc.) help regulate metabolism and size of skeletal muscle fibers. According to its metabolic effects, a possible role of growth hormone might be in maintenance of glucose level during exercise. Glycogen is the most important fuel for exercise. Fatigue is associated with both lactic acid build-up and glycogen depletion. One way to combat the onset of the fatigue during endurance exercise is to increase the amount of glycogen stored in the liver and muscles (6). GH and insulin are known to have antagonistic effects. Some have suggested that exercise induced GH elevations are at last partly responsible for the reduced insulin levels observed during exercise (2). According to this, the aim of this study was to analyze dynamics of changes in GH and glucose levels during acute workload and in the recovery period, in a group of well trained athletes.

Subjects and Methods

SUBJECTS

The study involved a group of 12 healthy males, on average 20 years of age. Inclusion criterion was regular participation in active training programs for at least two years before the study. Each subject underwent a detailed medical history and physical examination, and no subject had a history of pituitary, renal, hepatic, metabolic, or other systemic disease. Subjects refrained from exercise for 24 h before the study. Written informed consent was obtained from all subjects before the study.

EXERCISE PROTOCOL

All the tests were performed between 8-10 p.m. to avoid variation in growth hormone secretion. Subjects were required to consume their evening meal at or before 17.00 the day before to avoid possible confounding effects of meals on GH secretion. Subjects then fasted until the end of the study. Each subject completed a bicycle ergometer exercise test. Acute workload of 30 minutes duration was carried out on bicycle ergometer (LODE-Corival 400) following the protocol of individually adjusted constant work load. Work intensity was approximately 65 % of the workload achieved at $VO_{2\,max}$. Cycling cadence was 60 rpm.

LABORATORY MEASUREMENTS

Blood samples for GH and glucose level determination were taken using a plastic cannula that was inserted in subject's cubital vein before the exercise. The growth hor-

BODY MASS (kg)	80,20±2,11
BODY HEIGHT (cm)	186,31±2,05
BODY MASS INDEX (BMI)	23,1±0,97

TABLE 1. Subjects' physical characteristics Results are presented as ($\overline{X}$ ±SEM).

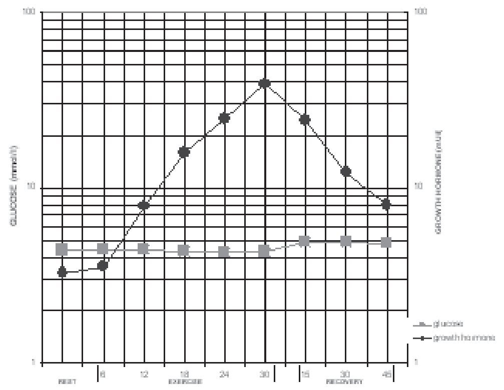

FIGURE 1. Dynamics of changes in GH level an glucose levels at rest, during exercise and in the recovery period

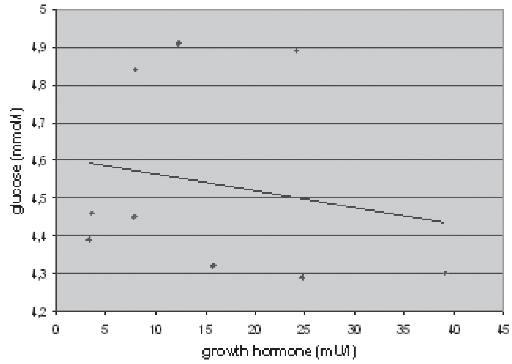

FIGURE 2. Correlation between growth hormone and glucose levels in serum during exercise and in the recovery period

mone concentration in the venous blood samples was measured in the rest, during exercise (6, 12, 18, 24 and 30 minutes) and during recovery (15, 30 and 45 minutes). The standard immunoradiometric (IRMA) method was used to determine serum growth hormone concentration. Serum glucose levels were determined by standard enzymatic method glucose oxidase (GOD PAP).

STATISTICAL ANALYSIS

Data are expressed as mean ± SEM. The statistical differences between groups were assessed by ANOVA. Differences within each group were evaluated by Student's t-test for paired data. The significance level for all tests was set at $p < 0.05$.

Results

Serum growth hormone and glucose concentrations at rest, during exercise and in the recovery period are presented on Figures 1 and 2. (*Values are presented in logharithmic scala.*)

Discussion

During high intensity, dynamic exercise the breakdown of high-energy phosphogens (ATP, CP) and the degradation of glycogen are the predominant energy yielding pathways. Although metabolic acidosis and ionic disturbances are thought to be the primary causes of fatigue during such exercise, carbohydrate availability may also play important role. Muscle glycogen is the predominant carbohydrate energy source during the early stages of exercise. Blood glucose availability becomes increasingly important as exercise continues (7). Increase in hepatic glucose output accompanies the increased peripheral utilization of glucose during exercise. Maintenance of glucose level during exercise is important factor of endurance exercise performance. During prolonged exercise lasting several hours hepatic glucose output may fall behind peripheral glucose utilization resulting in hypoglycaemia. There are a number of factors influencing this process (7). Exercise is one of the most important physiological stimuli of GH secretion, but the role of the GH during exercise is not well established (1,3,8). Our results showed that serum growth hormone concentration was successively increasing during acute workload. There was significant increase in serum GH levels in 12th minute of exercise. Our results concurr with those of some previuos studies. Moller et al. (3) showed that 10th minute of moderate exercise (60% of $VO_{2\,max}$) lead to significant increase in serum growth hormone concentration. During recovery period GH levels decreased, but it returned at the rest values in the end of recovery (45th min). The role of GH increase during acute exercise is not well known. According to its role in matabolism we suppose that GH could play role in maintenance of glucose level during exercise. Our results showed that glucose level during exercise remain unchanged compared with the level measured during rest. In the recovery period, there was an increase in glucose level, so we found significant differences between 15th, 30th and 45th minutes of the recovery compared with rest and with values measured at the end of exercise. But we have to stress that the levels of glucose were within reference range (3.3-6.3 mmol/l). These results are in accordance with those found in previous studies. Koivisto et al. (9) showed better ability of glucose maintenace in untrained subjects after period of aerobic training (6 weeks). Authors of this study suppose that the reason behind this is metabolic and morphological adaptation during treining, which leads to increased use of fat as energy fuel than carbohydrats. Manneta et al. (6) also showed better glucose serum levels maintenance in trained than in untrained subjects, followed by threefold increase of GH response during acute exercise. Our results showed no correlation between GH and glucose levels either during exercise or in the recovery period but we can not exclude possible role of GH in very good glucose level maintenance in athlets during exercise.

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