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THE EFFECTS OF MID-ALTITUDE ON ENDOCRINE PROFILE

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Abstract. Many of the physiologic changes that occur during acute and prolonged altitude exposure may actually negate adaptations that possibly improve physiologic performance upon return to sea level. Fourteen volunteer male students (male scouts) who inhabit at 1050 m were enrolled into the study to research; how mid-altitude affects some endocrine parameters. The basic evaluation was done before the camping at 3200 m, and the endocrine evaluation was repeated 10 days after, at the end of the camping. Volunteer students went through a general check up at the beginning. Blood samples were taken for determining the amount of growth hormone (GH), prolactine (PRL), follicule stimulating hormone (FSH), luteinizing hormone (LH), thyroid stimulating hormone (TSH), total triiodotyronine (TT3), total tyroxine (TT4), total testosterone (TTes) and cortisol levels. The levels of GH, PRL, FSH, LH, and TTes levels were changed after the camping period, and the difference found statistically significant ($p<0.05$). These observations suggest that exposure to altitude is associated with hyperprolactinemia and an impaired pituitary gonadal function. The alterations in the hormones levels are either be due to hypoxic stress or secondary to altitude induced hyperprolactinemia. The special characteristics of hypobaric hypoxia have been affected directly the endocrine profile.

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Key words: Mid-altitude - Endocrine parameters – Hormones - Hypobaric hypoxia

Introduction

In the world, about 40 million people live at altitudes of 3000-5000m, and also there are some people who live at higher altitudes. Although acclimatization is vital to survive, the rapid changes in altitude leave no time for acclimatization [4,12,13]. Hypoxia is an important factor at high altitudes. Since people living at high

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altitudes are not only under the effect of hypoxia, but also under other effects such as hypobaric conditions, cold, ozone, radiation, wind and low humidity. As a result of high altitude alterations occur in pituitary, gonadal and adrenal hormones. Endocrine system serves a model to provide homeostasis. It has shown a close correlation between emotional-physic stresses and physiological parameters are interrelated in a multifactorial way [7,20,24]. Behind the inconvenient environmental conditions, physical and emotional stress also affects homeostasis [13,19,20]. In both acute and chronic hypoxia, during relaxation and physical activity regulation of many hormones alters [5,10,17,27]. Many researches have been done previous years in this subject either under condition laboratory or at altitudes less than our study [1,4,10,22].

In this study, we aimed to observe the changes in endocrine profile at mid-altitude.

Materials and Methods

Fourteen volunteer scout students who the physical profile values were as; age 18±2.5 years, height 1.68±0.1 m. and weight 62.8±18 kg. inhabit at 1050 m, were enrolled into this study. Volunteers were high school students. The volunteers (n=14) were evaluated two times: first evaluation was done before camping, at an altitude of 1050 m on Erciyes University Campus (control values), and 10 days after, second evaluation was done after camping at 3200 m on Mount Erciyes (experiment values). All the volunteers went through a general health check-up and their physical findings were determined at Altitude Physiology Research Center Laboratory of Erciyes University.

Volunteer scout students who were used to live in lower altitudes(1050 m) applied to the camp and only did routine activities, which were environment, tent and kitchen cleaning, getting water.

Before and after the camping, 10 ml venous blood samples were taken between hours 08.00-10.00 from each subject and brought to the Central Medicine Laboratory of Erciyes University by cold-chain phenomenon.

Growth hormone (GH; Bio-coat GH RIA Kit, Belgium), prolactine (PRL; Centour Auto analyzer, Bayer-Deutschland), follicle stimulating hormone (FSH; Amerlex-M FSH RIA Kit, USA), luteinising hormone (LH; Kodak Amerlex-M LH RIA Kit, UK), thyroid stimulating hormone (TSH; hs TSH Coated Tube Assay, Johnson & Johnson, USA), total triiodothyronine (TT3; Amerlex –M T3 RIA Kit, Johnson & Johnson, UK), total thyroxine (TT4; Amerlex – M T4 RIA Kit, Johnson & Johnson, UK), total testosterone (TTes; Coat-A-Count, DPC, Los Angeles, USA) and cortisol (Corti; DSL RIA Kit, USA) levels were analyzed by using radioimmunoassay technique “coat–a count, DPC, USA “, “Amerlex-m, UK” and “IPC.UK“ kits were used for determining these hormones [9,15,27].

Statistical analyzes were done by SPSS 10.0 statistical packet program. Changes in the hormone levels were tested by non-parametric test-two paired sample test (Wilcoxon t test). P<0.05 was accepted as significant.

Results

Table 1
Comparison of the findings of control and experiment groups

	Physiological limits		Control values Altitude 1050 m (n=14)	Experiment values Altitude 3200 m (n=14)	
Hormones	Min	Max	Median (Min-Max)	Median (Min-Max)	p
GH (ngr/dL)	0.0	5.0	1.67 (0.01-3.95)	0.85 (0.01-3.66)	<0.05
PRL (ngr/dL)	4.0	8.0	8.45 (3.81-14.5)	11.9 (7.9-14.9)	<0.05
FSH (IU/mL)	1.0	9.2	9.38 (8.24-11.9)	10.5 (9.48-13.9)	<0.05
LH (mIU/mL)	3.0	13.5	4.45 (3.49-9.32)	6.64 (4.89-14.0)	<0.05
TSH (mIU/mL)	0.32	4.1	2.12 (0.8-3.65)	1.58 (0.93-3.42)	NS*
TT_3 (ngr/dL)	52	175	146.6 (83.7-171.4)	126.1 (113.8-168.9)	NS
TT_4 (μgr/dL)	4.8	12.8	8.52 (5.39-10.7)	8.59 (6.56-10.2)	NS
Testosterone (ngr/dL)	270	1070	215.2 (154.7-449.4)	357.1 (214.2-631.7)	<0.05
Cortisol (μgr/dL)	7	12	16.2 (4.86-24.6)	18.3 (13.8-78.1)	NS

*NS: Non Significant

It is significant the changes in hormon levels of the volunteers at an altitude of 3200 m (Mount Erciyes) compared to 1050 m on campus. Hormone levels of the volunteers have shown in Table 1. When the data of the control and experiment evaluation were compared, the differences in GH, PRL, FSH, LH, and TTes levels were found to be statistically significant ($p<0.05$). However, there was no difference in cortisol, TT3, TT4 and TSH levels ($p>0.05$). While the GH, TSH, TT3 changes were in negative manner, the PRL, FSH, LH, TTes and cortisol changes were in positive manner.

GH, TSH and TT3 levels were obtained respectively 35.3%, 4.8% and 7.4% in the decreasing proportions. PRL, FSH, LH, TTes and cortisol levels were obtained respectively 28.6%, 12.2%, 39.7%, 43.9% and 4.3% in the increasing proportions.

Discussion

The references on the effects of hypobaric hypoxia on the endocrine profile are rather limited. Exercise was shown to differentially affect endocrine profile of both sexes at altitude and sea level locations [8]. Some changes have been seen in the regulation of GH plasma levels under hypobaric hypoxic conditions. Determinants of GH secretion in adults are multifactor. Although ageing is immutable, body composition can be modified by appropriate diet and exercise [2,23,26]. This was the first time of volunteer scout students to high altitude exposure; also we especially selected the participants from the individuals who were not expose to moderate altitude. In the camp period the physical emotional stress factors were eliminated for preventing additional effects on endocrine profile.

Human GH characteristically increases during physical exercise. A significant increase in GH was noted using all methods after the marathon, followed by a significant decrease after recovery [1]. It is reported that factors inducing protein synthesis are related to these increases [16]. The hypoxia inhibits the growth hormone and induces somatostatin release from the hypothalamus [6]. It was reported that although there was a decrease of 50% in the protein synthesis in the hypobaric hypoxia, protein catabolism increased by 25% [18]. In our study the values of the GH after 10 days of camping at mid-altitude decreased significantly compared with those findings before camping. We have been supposing that the inhibitor response occurred possible via hypothalamus as well as the increase in protein catabolism, which may have occurred because of stress, exercise, hypoglycemia or L-Dopa [7,9,19,25]. We have though that hypobaric hypoxic area and its environmental effects can be influential in the GH decreasing in connection with inhibition of GH-releasing hormone, despite GH levels increased in much literature.

We did not encounter any reference on the amount of PRL plasma levels at mid-altitudes in the literature. It has been seen in our findings of PRL that there were significant increases. Since stress, tonic and rhythmic activities affected the serotonergic system directly, this system increased the hypothalamic neurosecretuar excitability. It is known that the serum prolactine levels did not change during repetitive magnetic stimulation [28]. We are of the opinion that PRL secretion may have increased due to the inhibition of dopamine secretion [8,9]. Our findings of after camping were showed a significant increase of the prolactine levels in the rate of 40%. These observations suggest that exposure to altitude is associated with hyperprolactinemia and impaired pituitary gonadal function [22,23].

It has been reported that there was no significant change in the plasma levels of FSH adenohypophysis hormones FSH and LH at increasing altitudes compared to sea level. Although there were increases in both hormones in our findings, the increases in FSH and LH were found to be significant [25]. FSH and LH levels in men are similar. But the secretion of these hormones is episodic. FSH and LH can be affected by the increasing of gonadotropin releasing hormone secretion on connection with hypothalamic control because of hypobaric hypoxia [12]. It is not known how physical activities affect gonadotropic hormones. However, it is reported that there may be increases in the secretion as well as the synthesis of the gonadotropic hormones and in the release as a result of the stimulation of peptidergic neurons through different stimulations of peptidergic neuron stimulants which support our findings [17,20,22,26].

It is reported that although testosterone plasma levels differ between acclimatized and unacclimatized people, they have different concentrations according to physical factors [4,13]. While testosterone levels decrease during heavy physical activity, they increase during light and mid-physical activity [8,14,22]. As with in our findings, when people who lead an urban life went up to high altitudes, their total testosterone levels increased compared to those who inhabit at high altitudes [2,3,8]. There are so many environmental factors causing the levels of FSH, LH and total testosterone needed for the spermatogenesis and accessory sex organ functions to decrease. We suppose that significant increases result from the fact that hypothalamus-leydig cell axis increasing the testosterone synthesis is caused by an effective stimulant. It is known that decreased levels of testosterone could be due to a reduction in the sensitivity of the testis to LH, or due to inhibition of steroidogenesis in the testis [3,17,22]. However in our study, testosterone levels have been found to be higher than control group findings. The exact mechanism of differences in the endocrine profile is unknown, but may be important in increasing the sensitivity of the hypoxic ventilatory response, activation of hemoglobin synthesis and the concentration of atmospheric nitrogen [2,12,27]. The volunteers might have been affected by many unknown other factors.

The plasma levels of thyroid hormones in hypobaric hypoxia are controversial [5,10,11]. TSH, TT3 and TT4 plasma are affected by cold weather as well as other conditions peculiar to high altitudes. While cold weather increases TSH levels, the breakdown of TT4 transformation in periphery leads to the amount of TT3 to decrease [11]. Physical activity and feeding habits affect TT3 and TT4 levels. These hormone levels may also be affected by 18% when exposed to a moderate cold [5]. It is reported that the plasma level of TSH and TT4 are not very important for a person's adaptation to cold and that even when they are exposed to extreme cold. Although there were changes in all forms of TT3, there was no significant difference in TT4 levels [11,21]. These findings agree with the literature in that there was no significant difference in the TT4 levels, while TT3 levels decrease significantly. The decrease in the TSH levels, it has been thought to be done by mediation a negative feedback of the peripheral stimuli, although the cold increases in adrenergic activity.

It is reported that cortisol has a negative correlation with the decrease in TSH and TT3 levels at high altitudes and stress is responsible for this negative correlation. Therefore, the plasma level of cortisol may increase [11,14,23], since many factors affect the cortisol levels in our findings also increased significantly in the literature. It has been made known that basal cortisol levels elevated at altitude and but the cortisol levels did not significantly increase after endogenous ACTH secretion [2,20]. It is thought that there is of the radiation effects on cortisol hormone levels at altitudes [28].

Conclusion

The hormones of adenohypophysis, thyroid and sex functions may cause the endocrine profile to change when under the effect of hypobaric hypoxia, radiation, ozone, cold weather, wind, and low humidity level, emotional and physical stress. The anabolic-catabolic hormone profiles are affected during camping at mid-altitude and so the athletic performance level of volunteers may have been impairing their activity at mid altitude. We also concluded that the lower GH concentration after camping at moderate altitude may have been a consequence of decreased physical performance. The mid-altitude effect result in an increase in the reproductive hormones (FSH, LH, PRL and testosterone). We suggest that the trend of effects-responses of these factors should be certainly formed.

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