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Hormonal Profile of Human Subjects Exposed to Antarctic Summer

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Abstract

The harsh challenging and extreme photoperiodic environment of Antarctica provides an ideal setting for studies of many human physiological and psychological variables. Of particular interest is the possibility of hormonal changes as one of the causative factors for these variations. A pilot study was conducted on summer expedition members to determine the hormonal profile of peripheral blood. The data suggest increased levels of prolactin and growth hormone, and decreased levels of Cortisol, triiodothyronine and thyroxine.

Introduction

Antarctica has been considered a natural laboratory for studying the effect of stresses on human health and behaviour. The Antarctic environment presents extremes of environmental stress to sojourners to this land. Above all, the continuous day or night plays a major role in adaptation of members of Antarctic expedition, who spend either summer or winter months in Antarctica. Besides these there are other psychoemotional stresses like social isolation, small close community living, hypo and hyperkinesia and sexual deprivation which complicate the normal activity and adaptation at polar station.

Assessment of hormonal profile is an important physiological index of adaptation to various stresses. Some studies have suggested a significant alteration in the thyroid and Cortisol levels during acclimatization to conditions in Antarctica (Lester *et al,* 1990; Kennaway and Van Dorp, 1991). Hormones play an important role in acclimatization to extreme conditions and it was thus thought useful to investigate blood levels of wide range of hormones before and after completion of 8 weeks stay during summer in Antarctica. The data obtained were specifically studied to determine the role of hormones in adaptation of expedition members to the combined impact of physical, psychological, geomagnetic and cosmic factors characteristic of Antarctica. These were pilot studies and based on these results further studies will be planned for subsequent expeditions.

The primary objective of our study was to evaluate the hormonal profile of peripheral blood on exposure of Indian men to Antarctic summer environment so that the underlying mechanisms of physiological and behavioural changes could be identified.

Materials and Methods

The investigations were conducted on 23 members of Tenth Indian Scientific Expedition to Antarctica. Nearly 40 members initially volunteered for the study; but due to non-availability of subjects on the days of experiment, 17 subjects were eliminated from the study. The study was conducted in three phases, Phase 1— the base line study was done on the ship. However, some have questioned how far (he base line data obtained during sea voyage are representative of initial status of the member, considering the psychological stress experienced during initial period of sea voyage. Therefore it has been planned that in future base line hormonal data will be obtained at AIIMS laboratory at New Delhi. Phase II— study was after 1 week of stay in the summer camp at "Maitri", the Indian Antarctic Station (70° S, 12' E) and Phase III— after 8 weeks of stay at Maitri (8 days before departure).

Blood samples were collected in the fasting state at 0730 AM after 8 hours of sleep. The baseline (Phase I) sample collection was done in the ship in a temperature controlled room 25±2°C, whereas at Antarctica it was in the non-heated summer hut with the ambient temperature ranging between 0-l0°C. There was 24 hours light during the period of study. The subjects were instructed to abstain from alcohol for 24 hours prior to test. The venous blood sample was obtained from antecubital vein. Their body weight, abdominal girth, midarm circumference were also measured. A centrifuge was used to separate the plasma and all the specimens were stored at -2()°C and brought back to AIIMS for analysis. The standard RIA (Radio Immuno Assay) technique was used. The commercially available kits from Diagnostic System Laboratories Inc., Texas were utilized to measure the levels of Cortisol (CRT), prolactin (PRL), leutinizing hormone (LH), thyroid stimulating hormone (TSH), thyroxin (T_4), tri-iodo thyroxine (T_3), insulin (INS) and growth hormone (GH). The radioactivity was measured using a gamma automatic counting system.

Statistical analysis was performed using one way analysis of variance for comparison of different time periods. Paired 't' test was used for comparing where only two readings were available.

Results

For ease of comparison between baseline hormonal levels and after exposure for 4 and 8 weeks in Antarctica, only those subjects in whom all the three phase samples were available are shown in the figures.

Blood Cortisol

The blood CRT levels of the members decreased (Fig. 1) significantly *(p<0.05)* after 4 weeks of stay, i.e. first half of the stay, but subsequently CRT value increased relative to initial value in Antarctica (9.86±21.13 µg/dl to 13.37±2.1 µg/dl).

The baseline value (12.75+2.8 µg/dl) is a higher value as compared to normal blood levels of resting men (2-25 µg/dl). Perhaps the initial anxieties due to sea travel, preparations, new experiences with food, persons and habitats resulted in this increased Cortisol levels.

The phase II levels of CRT are the low levels due to exposure to continuous day. During the later half of the exposure the blood Cortisol levels increased. This apparently reflected increased stimulation of hypothalamo-hypophysial adrenal axis due to combined stressful conditions (Fig. 1).

Prolactin

The prolactin secretion was insignificantly decreased in the initial phase of exposure (4.33±1.17 to 4.0±2.6 ng/ml). The standard reaction to stress is an increased secretion of prolactin (Mills, 1985) which was observed during phase III i.e. after a chronic exposure of 8 weeks.

Various authors have noted a decreased level of prolactin with cold exposure (Mills *et ah,* 1981; O'Malley *et al.,* 1984), suggesting that the response to extreme cold may differ from reaction to other forms of stress. The fact that in our study prolactin increased after 8 weeks of stay suggests that prolactin response was not due to cold stresses but other stress played a predominant role. Prolactin levels are marker of hypothalamic functions and is not related to sleep patterns (Fig.2).

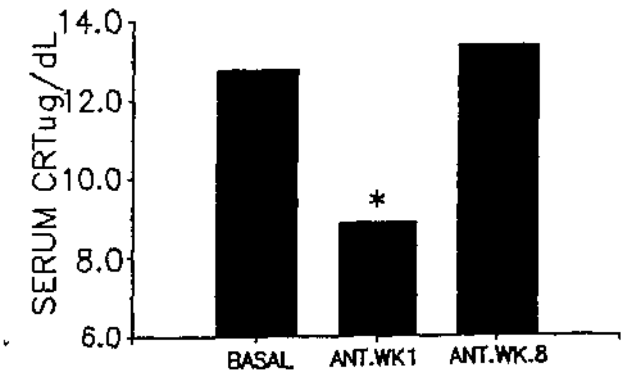

Fig. 1. The serum Cortisol showed a significant reduction after one of Antarctic stays which again came back to the higher level relative to basal value after 8 weeks of stay.
** = p< 0.05*

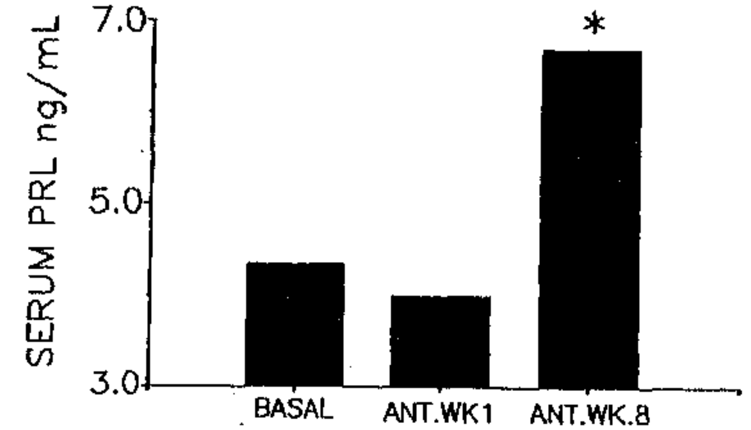

Fig. 2. The serum prolactin level showed an initial fall after one week of Antarctic stay, hut 8 weeks of stay led to a significant increase.
** = p< 0.01*

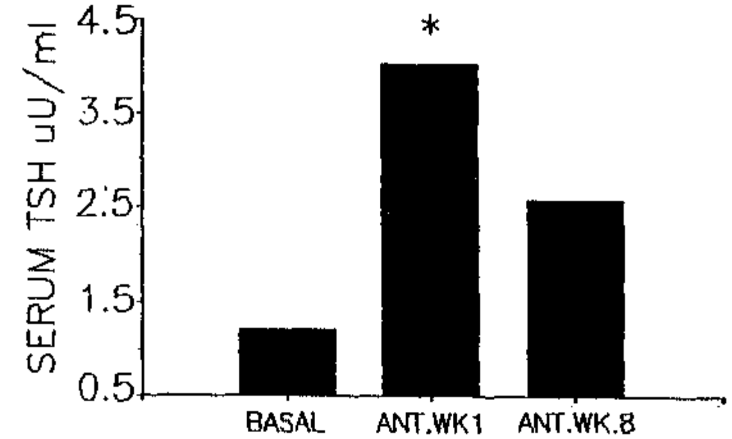

Fig. 3. One week of Antarctic stay led to a significant increase in the serum TSH level. Whereas 8 weeks of stay showed a return of TSH towards the basal level.

Thyroid stimulating hormone

The thyroid hormone, thyroxin (T_4) makes a special contribution to cold acclimatization, by stimulating the cellular metabolism (Shepard, 1983). The blood levels of TSH were increased significantly *($p<0.05$)* by 4 weeks of exposure to Antarctica. But by 8 weeks of stay the TSH value returned towards the baseline value (2.57 ± 1.1 μU/L)(Fig. 3).

The initial increase in TSH reflects a response to cold exposure, but the reduction of TSH level after sustained exposure indicates lowering of response of hypothalamo-hypophysial complex to thyroid hormones (Fig. 3). The change in sensitivity of hypophysial cells to thyrotropin releasing hormone (TRH) has been shown in human subjects an prolonged stay in Antarctica (Reed *et al.,* 1988).

Thyroid hormones

In our present study the total thyroxin (T_4) increased insignificantly in the initial phase of exposure but the total T3 was decreased. In phase III of the stay, the T4 levels significantly lowered 7.45±0.68 (basal) to 6.45±0.64 µg/dl along with persistent reduction in levels of T3 (Fig. 4).

These results suggest inhibition of secretory activity of thyroid with a distinctive inhibition of deiodination to T3. Reed et al.,(1988) have suggested a"T3 syndrome of Antarctica" observed in wintering personnel.

Leutinizing hormones

This is also a pituitary hormone which in male promotes testosterone secretion by the testis. The prolactin levels were marginally reduced during 1st half of summer stay but the LH showed a significant reduction (15.5±2.8 mlU/ml to 13.16±1.92 mIU/ml). On prolonged stay by 8 weeks there was substantial decrease in LH levels (12.16±4.12 mIU/ml) (Fig. 5).

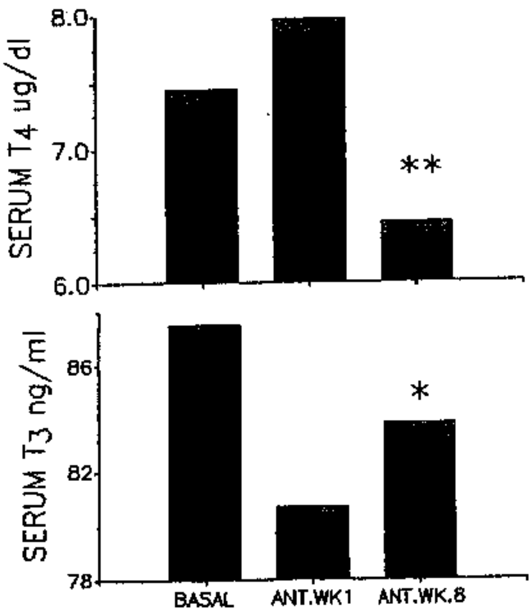

Fig. 4. Serum thyroxine (T4) level showed a slight increase after one week of Antarctic stay followed by a highly significant decrease after 8 weeks of stay. Serum T3 level showed a significant decrease after one and eight weeks of stay.
** = p<0.01 and ** = p<0.001*

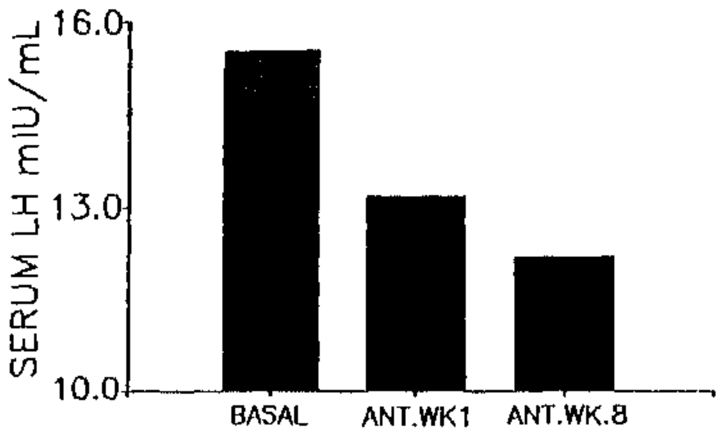

*Fig. 5. Serum LH level showed a significant decrease after one and eight weeks of slay at Antarctica, * =* p*<0.01*

It is not certain whether there was any decrease in testicular activity as the levels of testosterone was not estimated. It is also not certain whether LH suppression is due to stress or sleep disturbances, or related to prolonged day. A complex modulation of gonadotropic functions have shown to occur in adults (Van Cauter, 1990). In most mammals the LH secretion is reduced on exposure to continuous light (Van Cauter and Ratetoff, 1985).

In the present study there was no parallel change in the levels of PRL & LH which suggests that psychological stress is not the factor as the normal relationship of these two hormones had disturbed.

Growth hormone

The growth hormone secreted by hypophysis is related to feeding and sleep stages. The GH increased sharply (0.4±0.23 to 1.3±1.1 ng/ml) after 8 weeks of stay in Antarctica (Fig. 6). Although the increase was indicated by the 4th week of stay but this was insignificant. The alteration in photoperiod is known to reflect on the levels of GH (Van Cauter and Aschoff, 989) as well as the pattern of sleep (Van Cauter and Ratetoff, 1985).

Under normal stressful conditions GH and CRT show a parallel change but in Antarctica there was dissociation between GH and CRT thus indicating separate mechanisms for the release of these two hormones under combined stress of Antarctica.

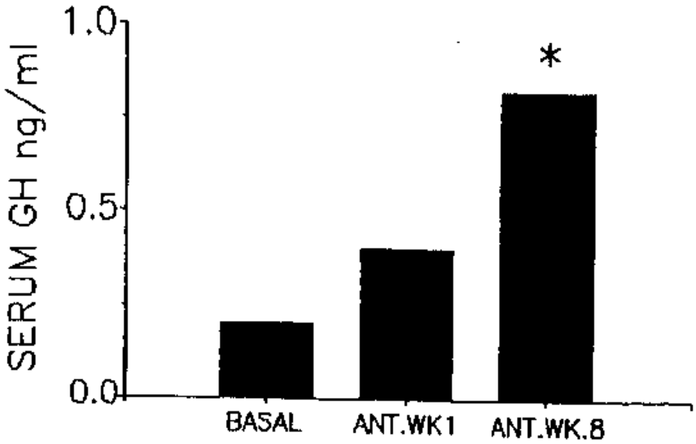

Fig. 6, Serum OH level showed an increase after one week of Antarctic stay which further increased significantly after eight weeks of stay,
** = p<0.01*

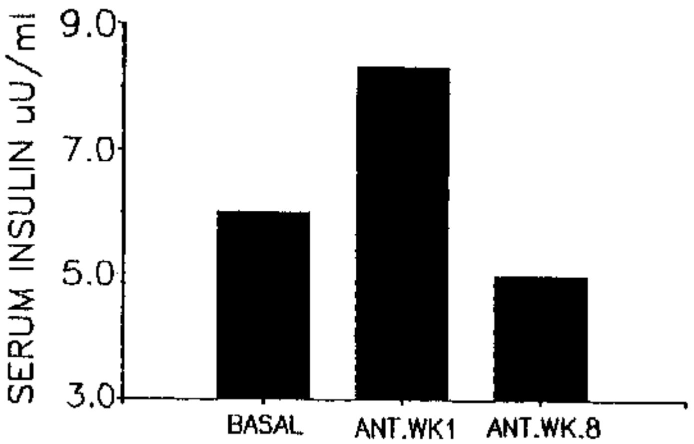

Fig. 7. Serum insulin level increased during phase I i.e., one week of Antarctic stay which then reduced after eight weeks of stay. The changes were not found to be statistically significant.

Insulin

Insulin which promotes the glucose uptake by cell is stimulated during stressful conditions. The blood levels of insulin was increased by phase I of our study (6.58+5.8 to 8.3±0.84 μU/ml) but on continuous stay it returned to normal levels (Fig. 7).

The data does suggest a paradoxical relation between low levels of CRT which is associated with raised insulin level in the initial phase of stress. But after acclimatization insulin levels decreased. Such changes have been shown earlier in human adaptation to higher latitudes (Van Cauter and Aschoff, 1989).

Conclusions

Chronic exposure to Antarctic summer for a period of 8 weeks resulted in alterations in levels of most of the hormones secreted by anterior pituitary i.e., prolactin, growth hormone and TSH. The initial response was variable. The commonly known stimuli to increase the output of these hormones are physical, thermal and psycho-emotional stresses. But the lowering of CRT (marker of stress) and reduced PRL in the initial phase indicate that stress mechanism was not the primary factor involved in activation of hypothalamo-hyphyseal stimulation. The increased levels of PRL (after prolonged exposure) and decreased levels of LH suggest some other unknown stimuli which result in this hormonal imbalance. Therefore it is essential to understand the role of light/dark cycle and geomagnetic effects on hormonal secretions, as it is well known that hormonal alterations may lead to psychosomatic disorders. Nevertheless, Antarctica is not always stressful.

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