

Changes of serum thyroid hormone and plasma catecholamine of 16th and 17th Chinese Expeditioners in Antarctic environment

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Abstract The serum thyroid hormone and plasma catecholamine were examined in 18 male and 2 female members of the Chinese Antarctic Expedition (who spent the 2000 or 2001 austral winter at the Great Wall Station). The changes of serum thyroid hormone i. e. total thyroxine (TT4) and free T4 (FT4), total triiodothyronine (TT3) and free T3 (FT3), thyroid stimulating hormone (TSH) and plasma catecholamine, including norepinephrine (NE), epinephrine (E) and dopamine (DA), were investigated by Chemoluminescence Immunoassay (CLIA) and High Performance Liquid Chromatography with electrochemical detection (HPLC-ECD). Samples were taken at different time: (1) 1 day before departure to Antarctica (16th expedition 1999/12/09; 17th expedition 2000/12/06). (2) 1 day after returned to China after living 54 weeks in Antarctica (16th expedition 2000/12/25; 17th expedition 2001/12/25). Comparing the data of before departure and returned, results showed that there was a significant decrease in the contents of TT4 ($P < 0.01$) with no significant change in the content of TT3, FT3 and FT4. It was also found that the content of TSH increased significantly ($P < 0.001$); No significant changes of plasma NE and DA were found but the content of E decreased significantly ($P < 0.001$). The results indicated that the special Antarctic environment led to a restrain effect on the thyroid function and the level of plasma E in Antarctic expedition members. Both the thyroid and adrenal medulla system were associated in response to the Antarctic systemic stress.

Key words Antarctica, expedition members, thyroid hormone, catecholamine.

1 Introduction

Due to the extreme environment, not only geophysical but also metaphysical isolation, there are both physiological and psychological stressors that the expeditors have to be faced with in Antarctica. It was reported that western people who had lived and worked in Antarctica for more than four to five months developed a characteristic constellation of symptoms and thyroid hormone changes called the Polar T3 syndrome. (Reed *et al.* 2001, 1995, 1990, 1986). Considering the difference of race, society and cultural background, maybe the physiological and psychological changes are different between Chinese and the western expeditions.

Antarctic research in China started in 1980. Since 1984, Chinese National Antarctic

Research Expedition (CHINARE) carried out in the Great Wall Station ($62^{\circ}12'59''\text{S}$, $58^{\circ}57'52''\text{W}$) and the Zhongshan Station ($62^{\circ}22'24''\text{S}$, $78^{\circ}22'40''\text{E}$) every year. A series of human physiological and psychological changes of the Chinese expedition members have been found in staying and working in Antarctic Great Wall Station and Zhong Shan Station. (Xue *et al.* 1989, 2000; Xue *et al.* 1990, 1994; Yu *et al.* 1991). Our previous results showed that plasma cortisol was increased and urinary adrenaline and noradrenaline were increased as well, but no data of plasma catecholamine were obtained (Xue *et al.* 2000). Therefore our present study is to observe the influence of psychophysiological chronic stress on neuroendocrine in the 16th and 17th winter-over Chinese expedition members. The changes of thyroid hormone and adrenal medulla hormone were examined and the relationships between them are expected to expose. Moreover we would like to learn the change of neuroendocrine in those of the 17th team which had two female members.

2 Methods

2.1 Objects

Objects for the study consisted of 18 male and 2 female members of 16th and 17th Chinese Antarctic Research Winter-over Expeditions who spent the 2000 or 2001 austral winter at Great Wall Station ($62^{\circ}12'59''\text{S}$, $58^{\circ}57'52''\text{W}$). The average age of 10 male 16th expedition members was 35.6 ($\text{SD} \pm 6.5$) years, and the average age of 10 members of 17th expedition (including 8 male and 2 female) was 39.9 ($\text{SD} \pm 6.7$) years. Everybody had past the evaluation as medically and psychologically qualified for winter-over duty. They departed and returned by airplane. The blood samples were taken at different time: (1) 1 day before departure to Antarctica (16th 1999/12/09; 17th 2000/12/06). (2) 1 day after returned to China after living 54 weeks in Antarctica (16th 2000/12/25; 17th 2001/12/25). Each individual was required to be fast, sitting and had a rest for 30 min before venous blood was taken. The blood sample was divided into two parts, one part was anti-coagulated by heparin (for test plasma catecholamine), and then centrifuged for 15 min (3000 r/min) in 4°C . Another part (for test serum thyroid hormone) was allowed to clot and centrifuged for 15 min (3000 r/min) at room temperature, and then separated and stored at -70°C until assayed. The samples of 16th expedition were co-assayed in the beginning of 2001. The samples of 17th expedition were co-assayed in the beginning of 2002.

2.2 Measures

2.2.1 Serum thyroid hormone

The serum thyroid hormone i. e. total triiodothyronine (TT3), free triiodothyronine (FT3); total thyroxine (TT4), free thyroxine (FT4) and thyroid stimulating hormone (TSH) were investigated by Chemoluminescence Immunoassay (CLIA). TT3, FT3; TT4, FT4 and TSH were analyzed with Automated Chemiluminescence's System (ACS: 180) CHIRON reagent box from Bayer company of Germany. The main ingredients are as following: (1) for TT3; monoclonal mouse anti-T3 antibody ($\sim 300 \text{ ng/vial}$) labeled with acridinium ester in buffered saline with sodium azide (0.1%), sodium barbital, and 1-anili-

nonaphthalene-8-sulfonic acid (ANS). (2) for FT3: monoclonal mouse anti-T3 antibodies (~ 40 ng/vial) labeled with acridinium ester in HEPES buffer with protein stabilizers and sodium azide (0.1%). (3) for TT4: monoclonal mouse anti-T4 antibody (~ 5 μ g/vial) labeled with acridinium ester in sodium barbital buffer with protein stabilizers, ANS, EDTA, and sodium azide (0.1%). (4) for FT4: acridinium ester-labeled T4 (~ 1.2 μ g/vial) in sodium barbital buffer with protein stabilizers, sodium azide ($<0.1\%$), and EDTA. (5) for TSH: monoclonal mouse anti-TSH antibody (~ 1.67 μ g/vial) labeled with acridinium ester in HEPES buffered saline with protein stabilizers, sodium azide ($<0.1\%$), and preservatives. The reference ranges for these assays are: TT3 0.66 – 1.92 ng/ml, FT3 1.80 – 4.10 pg/ml, TT4 4.30 – 12.50 μ g/dL, FT4 0.81 – 1.89 ng/dl, TSH 0.38 – 4.34 μ IU/mL.

2.2.2 Plasma catecholamine

The plasma catecholamines, including norepinephrine (NE), epinephrine (E) and dopamine (DA) were tested by High Performance Liquid Chromatography with electrochemical detection (HPLC-ECD), according to the method of Cheng LY (1990), using the catecholamine analytic instrument of Waters Company. The main ingredients of the agent (from Sigma company) includes norepinephrine (NE), epinephrine (E), normetanephrine (NMN), 3, 4-dihydroxyphenylacetic acid (DOPAC), dopamine (DA), metanephrine (MN), homovanillic acid (HVA) and 3,4-dihydroxybenzylamine (DHBA).

2.3 Statistical Analysis

Changes of serum thyroid hormone and plasma catecholamines upon departure and returning were assessed by means of paired samples t-tests. Difference value (the levels of departure subtracted from the levels of returning) of serum thyroid hormone and plasma catecholamines between 16th with 17th expedition were evaluated by means of one-samples t-tests. Bivariate comparisons were conducted using Spearman correlation coefficients, we compared the difference value of thyroid hormone levels with catecholamines using Spearman correlation coefficients. All test data was indicated by the form of $\bar{x} \pm S$. It indicated significant difference when $P < 0.05$, and more significant difference when $P < 0.01$.

3 Results

3.1 The changes of serum thyroid hormone TT3, FT3, TT4, FT4 and TSH

Results of both 16th and 17th expeditions showed that after living 1 year and 2 weeks in Antarctica, serum TT4 in the members' body decreased ($p < 0.01$), and TSH increased ($p < 0.001$). No significant change of serum TT3, FT3 and FT4 ($p > 0.05$) was found (Table 1). Comparison of the results of 16th with that of 17th expeditions, P reveals that there were statistically significant differences of in the levels of thyroid hormones (Table 1). The level of serum TT4 of 16th expedition decreased with statistical significance ($p < 0.01$), the level of serum TT4 of 17th expedition also decreased but without statistical significance ($p > 0.05$), and the level of TSH of 17th expedition ($p < 0.05$) increased significantly

less than that of 16th expedition ($p < 0.01$) (Table 1).

Table 1. The levels of serum thyroid hormones and plasma catecholamines in pre and post-Antarctic of 16th and 17th expeditions ($\bar{x} \pm S$)

	16 th and 17 th expeditions (n = 20)		16 th expedition (10 male members)		17 th expedition (2female and 8 male)	
	Departure	Returning	Departure	Returning	Departure	Returning
Thyroid hormones						
TT3 (ng/ml)	1.537 \pm 0.228	1.507 \pm 0.161	1.566 \pm 0.252	1.577 \pm 0.160	1.507 \pm 0.203	1.456 \pm 0.152
FT3 (pg/ml)	3.483 \pm 0.237	3.527 \pm 0.215	3.309 \pm 0.221	3.430 \pm 0.108	3.657 \pm 0.207	3.624 \pm 0.278
TT4 (μ g/dl)	8.211 \pm 0.907	7.519 \pm 0.951 **	8.047 \pm 1.168	7.227 \pm 0.938 **	8.392 \pm 0.616	7.843 \pm 1.056
FT4 (ng/dl)	1.453 \pm 0.144	1.447 \pm 0.138	1.387 \pm 0.161	1.424 \pm 0.094	1.526 \pm 0.120	1.473 \pm 0.190
TSH (μ IU/ml)	1.584 \pm 0.523	2.174 \pm 0.707 ***	1.544 \pm 0.461	2.099 \pm 0.532 **	1.625 \pm 0.602	2.250 \pm 0.856 *
Catecholamines						
NE (ng/ml)	0.611 \pm 0.168	0.642 \pm 0.167	0.631 \pm 0.132	0.684 \pm 0.196	0.591 \pm 0.201	0.599 \pm 0.135
E (ng/ml)	0.121 \pm 0.040	0.070 \pm 0.027 ***	0.119 \pm 0.038	0.071 \pm 0.020 *	0.124 \pm 0.041	0.069 \pm 0.034 ***
DA (ng/ml)	0.065 \pm 0.055	0.034 \pm 0.031	0.059 \pm 0.062	0.031 \pm 0.026	0.071 \pm 0.046	0.037 \pm 0.036

Significance level threshold, comparing departure with returning, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Departure: 1 day before departure to Antarctica. Returning: 1 day upon returning to Beijing after living 54 weeks in Antarctica.

3.2 The changes of plasma catecholamine NE, E and DA

Results of both 16th and 17th expeditions showed that after living 54 weeks in Antarctica, in the member's bodies plasma E decreased ($p < 0.01$), and plasma DA decreased but without statistical significance, and plasma NE remained unchanged (Table 1). The level of plasma E of 17th expedition ($P < 0.001$) decreased more significant than that of 16th expedition ($p < 0.05$) (Table 1).

3.3 The association between serum thyroid hormone and plasma catecholamine levels

We compared departure with returning and found that difference values of TSH were significantly associated with difference values of norepinephrine (NE) ($r = .532$, $p = 0.016$); difference values of TT3 were significantly associated with difference values of NE ($r = -.501$, $p = 0.024$) (Table 2).

3.4 Comparing of 16th with 17th expeditions

The difference value of serum thyroid hormone and plasma catecholamines is derived from the levels of departure deducting the levels of returning. By means of one-samples t-tests, the results indicated that the difference values of serum thyroid hormone and plasma

catecholamines between 16th with 17th expeditions had no significant difference.

Table 2. Spearman rank order correlations of difference value in thyroid hormones with Catecholamines at Pre and Post-Antarctic of 16th and 17th expeditions (n = 20)

Catecholamine	Thyroid hormones				
	Total T3	Free T3	Total T4	Free T4	TSH
NE	-.501 *	-.332	-.344	-.095	.532 *
E	.088	-.253	-.020	.112	-.116
DA	.125	-.138	.121	.066	-.178

* P < 0.05

4 Discussion

It is well known that the west expeditioners who lived in Antarctica for more than 5 continuous months develop the polar T3 syndrome. The syndrome is characterized by an elevation in TSH, a small decline in serum FT3 and FT4 (Reed *et al.* 2001). It was reported that 17 healthy euthyroid men of American expeditioners (aged 26 ± 1 years old) stayed in Antarctica after 42 weeks, a 50% elevation in the serum TSH response to TRH, and a fall in serum TT3 and FT3 were found, Serum TT4 and FT4 levels fell slightly but not significantly (Reed *et al.* 1986). However, the results from the tests of Chinese 16th expedition members showed that after living 54 weeks in Antarctica, serum TT4 in their bodies decreased ($p < 0.005$), and TSH increased 35.9% ($p < 0.001$), but no significant change of serum TT3, FT3 and FT4 ($p > 0.1$) was found. Being different from the above results of American expeditioners, our results had no changes of serum TT3, FT3 and FT4, but had decline of serum TT4 and increase of TSH. A typical case was also reported, young euthyroid subjects of American which were 19 ~ 41 years old, were divided into two groups. One group showed neither a circannual pattern of TSH nor that of TT4 during the winter season in American local place. But the other group living for more than 20 weeks in Antarctica showed an elevation of approximate 30 – 50% in TSH and small declines in TT4 (Reed 1995). The result of 16th Chinese expedition was similar to this case.

It was found that the level of TT3 is normal; TT4 is decreased and TSH is increased in the serum of hypothyroid. For adults, hypothyroidism is characterized by poor mentation, poor memory, and lack of initiative, and other psychological changes may also occur. The results of Chinese 16th expeditions showed some the characteristics of subclinical hypothyroidism.

Specifically, we had observed the association between hormone levels and mood scores (POMS test) on the Chinese 16th expeditions members (Xu *et al.* 2003). We found the following results: low levels of TT3 and total T4 and high levels of TSH were significantly associated with high levels of tension anxiety, depression, anger, confusion, and total mood disturbance. Moreover, increases in TSH above the baseline to the end of winter were significantly associated with increases in fatigue and total mood disturbance. Meanwhile, low levels of dopamine (DA) were significantly associated with high levels of tension-anxiety, tendency of anger was significantly associated with an increase in adrenalin. Being consistent with the findings in the American expeditioners case (Palinkas *et al.* 2001; Reed *et al.* 2001), the thyroid hormone levels of the Chinese expeditioners were significantly associated

with mood states, so as for dopamine and adrenalin.

Comparison the results of 16th with that of 17th expedition, reveals that there were differences of statistical significance in the levels of TT4, TSH and E (table 1). But when we compared the difference value of serum thyroid hormone and plasma catecholamines between 16th with 17th expeditions, the results indicated that the changes of two expeditions had no significant differences. When we put results of both 16th and 17th expeditions together for statistics, it was showed that the tendency of changes of two expeditions is identical to that of 16th expedition. When we eliminated 2 female expeditors ($n = 18$), the statistic result of 18 male expeditioners was identical with the result of 20 expeditioners. These statistic results indicated that there are no differences between 16th and 17th expedition. It means the Antarctic extreme environment does the same effect to the 16th and 17th expedition. The small number of subjects of each expedition may effect and limit statistical significance.

The reason induced the different changes of the hormone levels between the 16th and 17th expeditions, might be there were two females in the 17th expedition (one was a doctor and another was an administrator), hence the male members paid more attention to their behaviors, trying to be more polite and gentle with each other, to keep themselves more capable and powerful, to show their tolerance and magnanimousness. Due to the existence of two females changed the working and living atmosphere of the 17th expedition during the stay in Antarctica, thus lightened psychological stress and negative mood. As mentioned by Law (Law 1960) that in Antarctic "Their sense (expeditioners) of isolation was increased by the lack of female companionship, and the lack of daily contact with a wide range of people." Further observing and studying on the effects of female expeditioners to the whole expedition is needed.

We could not examine the circannual changes of plasma catecholamine and serum thyroid hormone in this time, further research is required.

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