IMMUNOLOGY AND MICROBIOLOGY

Dependence of Immune System Function and Metabolism on Reactive Anxiety

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Reactive anxiety, immune system function, and metabolism were studied in healthy volunteers. Temperament characteristics, state of health, number of leukocytes and platelets, and concentration of glucose, albumin, and fibrinogen significantly differed in subjects with low, moderate, and high level of reactive anxiety.

Key Words: *reactive anxiety; immune system; albumin; temperature*

Recent studies clearly demonstrated the interactions between the immune, nervous, and endocrine system. The brain modulates the function of the immune system via neuropeptides and neurotransmitters [5,9]. Immunocompetent cells carry receptors for neurotransmitters. Neurons not only react to cytokines, but also synthesize these substances. Published data show that the immune system modulates brain activity, body temperature, sleep, and feeding behavior [7,12]. It is important to evaluate the relationship between metabolism, characteristics of immune system function, and higher nervous activity in humans.

Reactive anxiety (RA) serves as a factor modulating immune system function. Moreover, RA determines the reaction to external stimuli. The increase in RA is accompanied by strain, agitation, and anxiety even under normal conditions.

Here we studied the relationship of RA with immune system function and metabolism.

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MATERIALS AND METHODS

We examined 44 healthy volunteers (21 women and 23 men). RA was estimated by the Spielberger—Hanin inventory [2]. We also used health-activity-mood (HAM) questionnaire. Temperament was evaluated according to Strelyau [4]. Immunological studies included level II extended immunogram. Metabolic characteristics were determined routinely [3].

The significance of intergroup differences was estimated by nonparametric Mann—Whitney test and Wald—Wolfowitz test. Spearman correlation test and Kendall correlation test were used to estimate the relationship between various parameters [1].

RESULTS

According to our method, there are low (up to 30 points), moderate (31-45 points), and high levels of RA (46 points or more). Low, moderate, and high RA was observed in 12, 24, and 8 subjects, respectively. The age of subjects with various levels of RA was practically similar (Table 1).

TABLE 1. Characteristics of Psychological State in Subjects with Various Levels of RA (Score)

Parameter	Low RA	Moderate RA	High RA
Age, years	45.55±2.27	49.34±2.41	51.87±1.44
RA	26.58±0.98	36.83±0.86*	50.62±1.51*+
State of health	6.16±0.15	5.55±0.18	4.01±0.66*+++
Activity	5.26±0.25	5.03±0.22	3.83±0.42**+++
Mood	6.24±0.16	5.79±0.16	4.37±0.52*++
Degree of excitement	56.00±4.44	51.08±2.65	39.25±4.43***+++
Degree of inhibition	61.00±2.52	60.39±2.06	55.50±3.52
Mobility	54.10±3.16	53.96±2.27	40.75±4.26***++
Balanced state	1.01±0.09	0.851±0.037	0.744±0.073

Note. *p<0.001, **p<0.01, and ***p<0.05 compared to low RA; +p<0.001, ++p<0.01, and +++p<0.05 compared to moderate RA (Mann—Whitney test).

The results of HAM test and Strelyau tests strongly depended on the level of RA. The score of health, mood, and activity in subjects with high RA was lower than in those with low RA (by 1.54, 1.43, and 1.4 times, respectively; Table 1). It should be emphasized that subjects with various levels of RA significantly differed in temperament characteristics. The degree of excitement in subjects with high RA was much lower than in those with low and moderate RA (by 30.0 and 23.2%, respectively). Mobility of nervous processes in subjects of the high RA group decreased by 1.3 times. However, the degree of inhibition and balanced state of nervous processes did not depend on the level of RA.

Immune system function and metabolism depended on the level of RA. Transition from low to moderate RA was accompanied by an increase in the number of platelets and $CD95^+$ lymphocytes in the peripheral blood (Table 2). Glucose concentration in subjects with moderate RA increased by 1.3 times. Leukocyte count in subjects with high RA was lower than in those with moderate RA. Albumin concentration significantly differed only in subjected with high RA. The absolute and rela-

TABLE 2. Immune System Function and Metabolism in Subjects with Various Levels of RA

Parameter	Low RA	Moderate RA	High RA
Blood leukocytes, $\times10^9$/liter	6.67±0.52	7.13±0.32	6.83±1.25+++
Platelets, $\times10^9$/liter	333.9±30.2	348.4±11.1++	309.7±27.11
CD95+ cells, %	15.92±1.59	16.50±1.88	16.38±1.99
CD95+ cells, $\times10^9$/liter	0.227±0.050	0.242±0.031+	0.213±0.047
Activity of phagocytosis, %	30.50±4.02	38.13±3.68	41.50±4.78
Intensity of phagocytosis, arb. units	1.03±0.15	1.616±0.240	1.73±0.35
Glucose, mM	3.29±0.42	4.20±0.16*	4.03±0.30
Albumin concentration, g/liter	46.70±1.05	45.29±0.63	42.57±1.09**+++
Albumin concentration, %	61.33±1.28	59.13±0.97	57.71±0.78*
Plasma protein, g/liter	74.50±1.30	72.41±3.42	73.71±1.87
α_1-globulins, %	3.90±0.38	4.042±0.210	3.71±0.28
α_2-globulins, %	9.10±0.57	8.13±0.49	8.71±0.84
β-globulins, %	10.50±0.96	11.63±0.68	11.29±0.78
γ-globulins, %	16.10±1.36	16.75±1.11	18.57±1.09
Sialic acids, arb. units	2.31±0.11	2.19±0.06	2.09±0.16
Fibrinogen, g/liter	3.02±0.16	3.17±0.15	2.54±0.13*,**

Note. *p<0.05 compared to low RA, **p<0.01 compared to moderate RA (Mann—Whitney test); +p<0.05 and ++p<0.01 compared to low RA, +++p<0.01 compared to moderate RA (Wald--Wolfowitz test).

TABLE 3. Correlation Coefficients for RA

Parameter	*n*	Correlation coefficient	*p*
State of health, points	44	R_S=-0.5720	0.00005
Activity, points	44	R_S=-0.3405	0.024
Mood, points	44	R_S=-0.5130	0.0004
Degree of excitement, points	41	R_S=-0.4357	0.004
Balanced state, points	41	R_S=-0.3749	0.016
Activity of phagocytosis, %	44	R_S=0.3350	0.026
Intensity of phagocytosis, arb. units	44	R_S=0.3220	0.033
Albumin concentration, g/liter	41	R_S=-0.3760	0.015
Albumin concentration, %	40	R_S=-0.3740	0.017
β-globulins, %	41	R_K=0.2220	0.040
Fibrinogen, g/liter	40	R_S=-0.3450	0.029
Sialic acids, arb. units	40	R_K=-0.2260	0.040

Note. R_S, Spearman correlation coefficient; R_K, Kendall correlation coefficient.

tive concentration of albumin decreased in subjects of this group (Table 2). Similar differences were found in plasma fibrinogen concentration. However, total protein content and concentrations of α_1-, α_2-, β-, and γ-globulins did not differ in subjects with various levels of RA.

The relationship of RA with immune system function and metabolism was estimated by calculation of correlation coefficients. The level of RA negatively correlated with activity, state of health, and mood (Table 3). Negative correlations were found between RA, degree of excitement, and balanced state of nervous processes. Subjects with various levels of RA did not differ in the balanced state of nervous processes. High level of RA is characterized by endocrine changes typical of the stress response. Subjects with high RA exhibit an increase in the concentration of glucocorticoid hormones (GCH) and catecholamines [8]. We revealed a negative correlation between RA and albumin concentration (Table 3), which is consistent with published data that GCH can impair albumin synthesis in the liver [10]. GCH stimulate the synthesis of other proteins [6], which probably contributes to a positive correlation between the level of RA and β-globulin concentration. Moreover, inflammation is accompanied by an increase in the concentration of fibrinogen and sialic acids [11]. These changes can determine the negative correlation of RA with fibrinogen and sialic acids.

Our results show that subjects with low, moderate, and high levels of RA differ in psychological state, metabolism, and immune system function. These specific features probably underlie the development of disorders under extreme conditions.

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