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Impact of Noise Stress on the Immune Status of Albino Rats

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ABSTRACT

Chronic exposure to loud noise acts as a stressor which affects not only the auditory system but also the extra auditory systems of our body leading to various health disorders. But for few studies, the effect of chronic noise exposure on the immune status of the individual is not well documented. The aim of the present study was to determine the effect of chronic noise exposure on the immune parameters in albino rats. Exposure to noise stress for 15 days caused an increased in the spleen weight , spleen cell count , thymus weight and thymus cell count whereas 30 day noise exposure did not alter these parameters. The antibody titre was lowered while the leukocyte migration was not affected in noise stress group. The lymphocyte count was increased and the neutrophil count was decreased. The total leukocyte count was unaltered while the corticosterone level was suppressed. In conclusion, the chronic exposure to noise acts as a stressor affecting the various parameters of the immune functions differentially depending on the duration of exposure.

Key words: Antibody titre, corticosterone, noise stress, immune function, spleen, thymus

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INTRODUCTION

Noise has become the most commonly encountered stressor in our daily lives and hence chronic high intensity noise exposure becomes an environmental pollutant. Depending on the frequency, intensity and duration of exposure noise affects the various systems of the body in different ways. Exposure to noise of high intensity causes hearing loss, damage to hair cells and affects the auditory cortex [1]. Chronic noise stress affects the extra-auditory system by causing hypertension [2], duodenal ulcers [3] , behavioural disturbances [4] and learning and memory deficit [5]. Though noise is known to affect almost all the systems of the body, so far very few studies have been done on the effect of noise stress on immune system. As exposure to noise affects one's life, it is highly pertinent to study the effect of chronic noise exposure on the immune response in albino rats.

MATERIALS AND METHODS

Experimental Animals

Male albino rats (Wistar strain) weighing 150-200 gm were used for the study. The animals were reared in the animal house of the Institute and were maintained under standard laboratory conditions with food (Hindustan Lever Ltd., Bangalore, India) and water ad libitum in a 12 hour light and 12 hour dark cycle. Ethical clearance was obtained from the ethical committee of the institute before the commencement of the experiments.

Experimental design

The animals were divided into three groups of 9 animals each.

Group 1- Control: This group is exposed only to normal environment.
Group 2 - These animals were exposed to chronic noise stress for 4hr/day for fifteen days and sacrificed on the sixteenth day.
Group 3 - These animals were subjected to chronic noise stress for 4hr/day for thirty days and sacrificed on the thirty first day.

Noise Stress Procedure

Broad band (White) noise at 100dB intensity was used for the study. The sound was produced by a white noise generator. This was amplified by an amplifier (40 watt) which was connected to a loud speaker fixed 30cm above the animal cages. A sound level meter (Cygnet, D 2023) was used to measure the intensity of noise. The background noise level in the stress room was at 44±2dB due to the ventilation system. Throughout their stress exposure period these animals remained in the stress room to prevent other unnecessary stress on the animals.

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Biological assays

The blood collection and animal sacrifice was done between 8.00-10.00 a.m in order to avoid variations in the parameters studied due to circadian rhythm. The animals were anaesthetized with ether according to the stress free procedure [6] . Non heparinized and heparinized blood samples were collected from the jugular vein for haematological studies and steroid estimation. The spleen , thymus and popliteal lymph nodes were removed, blotted and weighed. Spleen and thymus were then immediately used for doing the cell count. The total leukocyte count and differential leukocyte count were determined by standard methods. Serum was separated from the unheparinized blood and used for estimating antibody titre for assessing humoral immunity by the direct haemagglutination method. The cell mediated immunity was assessed by the Leukocyte migration inhibition (LMI) test (Sensitized T lymphocytes in the presence of the corresponding antigen produce migration inhibition factor (MIF) which inhibits the migration of leukocytes from capillary tubes. Immunodeficient lymphocytes fail to release MIF) [7]. The plasma corticosterone level was estimated by the spectrofluorimetric method [8].

Statistical Analysis

The data obtained in this study was statistically analysed using One Way Analysis of Variance (ANOVA) followed by Tukey's Multiple comparison test. The values were expressed in the Table1 and Table 2 as mean±standard deviation. $P<0.05$ was considered statistically significant.

Table 1: Effect of noise stress on leukocyte count , humoral and cell mediated immunity

Parameters	Group 1 (Control)	Group 2 (15 day noise stress)	Group 3 (30 day noise stress)
Total leukocyte count (cu mm)	14317±547	11022±474	13870±796
DC - Lymphocyte %	68.9±.54	79.7±.71	81.1±.53
DC - Neutrophil %	20.65±.35	10.06±.36	8.47±.35
Corticosterone (µg/dl)	42.38±1.26	10.89±.28	15.77±1.42
Antibody titre (Humoral immunity)	1.55±.11	0.20±.11	0.21±.1
Leukocyte migration inhibition index (Cell mediated immunity)	0.87±.01	0.81±.11	0.82±.11

Table 2: Effect of noise stress on organ weight and cell count of spleen and thymus

Parameters	Group 1 (Control)	Group 2 (15 day noise stress)	Group 3 (30 day noise stress)
Spleen (Organ weight/body weight ratio)	3.84±.11	4.49±.24	3.91±.21
Spleen cell count (x 10^8 cells/spleen)	4.5±.88	6.3±.19	4.15±.24
Thymus (Organ weight/body weight ratio)	1.14±.04	2.05±.08	1.22±.03
Thymus cell count (x 10^8 cells/thymus)	4.7±.09	9.55±.54	3.21±.21
Spleen (Organ weight/body weight ratio)	0.206±.017	0.219±.005	0.325±.014

RESULTS

Chronic noise stress suppressed the antibody titre but did not alter the leukocyte migration inhibition index. The lymphocyte count was increased , neutrophil count was decreased and no changes were observed in the total leukocyte count. The corticosterone level was suppressed in the noise stress group (Table 1). Exposure to noise stress significantly increased the organ weight and cell count of spleen and thymus only for 15 days duration whereas further exposure to 30 days failed to show any significant variation with control while the lymph node weight was enhanced proportional to the noise exposure (Table 2).

DISCUSSION

The exposure to chronic noise stress caused an increase in the percentage of lymphocytes and a decrease in the neutrophil percentage with no significant changes being observed in the total leukocyte count. Activation of hypothalamo-pituitary adrenal system leads to the corticosteroid related reduction in absolute number of lymphocytes [9]. In this study, the plasma corticosterone level was significantly lower in the noise stress group compared to the control. Thus the reduced corticosteroid may be the reason for the increased lymphocytes. The percentage of lymphocytes and neutrophils are inversely related to each other both in basal and stressed conditions. Thus the decrease in the neutrophil count could be secondary to the increase in the lymphocyte count.

The decrease in the plasma corticosterone level in chronic noise exposure may be due to the operation of the adaptation process in the animals due to expose to the same stressor over a long period of time as in our previous studies in albino rats exposed to acute noise stress, a significant increase in the plasma corticosterone level, thymus weight and cell count along with significant decrease in the antibody titre, spleen weight and cell count was observed. No significant changes were observed in the LMI and organ weight of lymph node in these animals indicating acute noise to be a potent stressor causing definite alterations in the immune functions of the albino rats [10]. Though the exact mechanism behind this corticosteroid suppression is not fully known, similar adaptive response of corticosteroid has also been reported in rats exposed to one month chronic stress [11]. Further it was shown that repeated administration of noise stress and CRF desensitizes the neurons of the locus coeruleus while acute administration of both activates the locus coeruleus. Using electrophysiological response of locus coeruleus as an assay, it was shown that repeated white noise stress resulted in reciprocal cross-desensitization between the CRF and stress [12]. This interaction between the CRF and the locus coeruleus may be the reason behind the mechanism of adaptive response to stress.

Antibody titre reflects humoral immunity. A significant decrease in the antibody titre was observed in the noise stress group which could be due to the suppression of B cell activity due to chronic noise exposure. [13,14]

Noise exposure for 15 days has increased the organ weight and cell count of spleen and thymus . The significant increase in the spleen weight and count may be due to an increase in the number of splenic macrophages [15]. The increased organ weight of thymus could be due to an increase in the thymocyte number [16]. This could be due to the effect of

the autonomic nervous system which innervates extensively both thymus and the spleen. The autonomic nervous system permits the movement of thymocytes and T cells to the gland by selectively altering the permeability of thymic blood barrier. In our study, chronic (30 day) noise exposure did not alter the organ weight of spleen and thymus which might be due to adaptation of the system due to chronic noise stress. Studies were available to show that, changes occurring in spleen and thymus weight due to acute noise exposure decreased and the response turned into a chronic inhibitory state in chronic noise exposure [17].

Leukocyte migration was not altered as indicated by LMI index in noise stress. In this study, the thymus cell count showed a marked increase in 15 day stress group but not in the 30 day stress group. However the lymph nodes weight showed a marked increase in the 30 day stress group animals as in previous studies [18], suggesting a redistribution of leukocytes in the different lymphoid organs.

CONCLUSION

Thus exposure to chronic noise acts as a stressor causing definite alterations in the various parameters of the immune functions differentially depending on the duration of chronic noise exposure, possibly due to sequential activation of different physiological mechanisms. Therefore, the impact of noise stress on immune status needs further in depth study.

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