INTRODUCTION

Protective immunity is conferred by the complementary actions of two separate but interdependent components of the immune system: the innate immune system and the adaptive or acquired immune system. The responses of these two systems differ in timing and in the selectivity of the defense mechanisms [1]. The innate immune system encompasses the body’s non-specific immune responses that come into play immediately on exposure to a threatening agent. In contrast, the adaptive or acquired immune system relies on specific immune responses selectively targeted against a particular foreign material to which the body has already been exposed.

Vestibular apparatus is located in the inner ear and it is the sense organ for balance. It starts functioning from the 5th month of gestation [2]. One of the newest and most popular therapies for developmentally delayed children is vestibular stimulation. Controlled vestibular stimulation by swing can be applied not only as an intervention for learning disability but also to relieve stress, cancer pain, to promote sleep to improve immunity and also to treat endocrine disorders [3-7].

Stress may be defined as lack of congruence between important aspects of the person and his perceived environment [8]. Stress is a priceless poison of 21st century; stress harms different parts of the human body from muscles and tissues to organs and blood vessels. It increases pulse rate, respiration, blood pressure and body temperature. It can also interfere with the body metabolism, digestion, appetite, sleep, sexuality, and fertility [9]. Stress will increases susceptibility to infections by suppressing immunity. However, the effect of acute and chronic stress on immune functions varies. Acute stress cellular immunity whereas chronic stress suppresses immunity and also to treat endocrine disorders [3-7].

We hypothesized that vestibular stimulation prevents stress-induced suppression of immunity by inhibiting the stress axes. To test this hypothesis total leucocyte count, differential leucocyte count, platelet count, hemoglobin level, organ weight of spleen and liver were observed following vestibular stimulation in cold water swimming stress induced Wistar albino rats.

METHODS

The present study was approved by Institutional Ethical Committee no: EC/4/23/5/24.

Animals

Totally, 24 healthy, adult male albino rats of Wistar strain were used in the present study. Rats were housed under standard laboratory conditions with food and water provided ad libitum. Rats were randomly assigned into four groups.

Group A: (n=6) Control group (neither stress nor vestibular stimulation).
Group B: (n=6) Stress group (cold water swimming stress only).
Group C: (n=6) Cold water swimming stress + vestibular stimulation with cold water applied for 15 days.
Group D: (n=6) Cold water swimming stress + vestibular stimulation with hot water applied for 15 days.

Cold water swimming stress

Rats were forced to swim in the plastic tubs (height: 60 cm, diameter: 40 cm) containing cold water, maintained at 10°C. The middle ear cavity was irrigated with hot (40°C) or cold (15°C) water through a polyethylene tube for 15 days.

Caloric vestibular stimulation

The middle ear cavity was irrigated with hot (40°C) or cold (15°C) (Fig. 1) water through a polyethylene tube for 15 days [15,16].
Body weight was measured before and after the stress period in all the rats. The animals were sacrificed by decapitation and blood samples were collected. The wet weight of the organs (liver, spleen) was expressed per 100 g of body weight. TLC, DLC, platelet count, and hemoglobin were estimated by standard methods.

**Data analysis**

Data were analyzed by SPSS 20.0. Statistical tests used are two-way RM ANOVA and Bonferroni post-tests.

**RESULTS**

The results are presented in Figs. 2-8.

Hemoglobin levels increased significantly on 1st day in stress + hot water vestibular stimulation group, on 7th day in stress only, stress + cold water vestibular stimulation groups, on 15th day in stress only, stress + cold water vestibular stimulation, and stress + hot water vestibular stimulation when compared to control group. Hemoglobin levels decreased significantly on the 7th day in hot water vestibular stimulation group when compared to stress only group, however, it is not statistically significant when compared to control group.

TLC is decreased in stress only group when compared to control group. However, it is not statistically significant. TLC increased in stress + cold water vestibular stimulation and stress + hot water vestibular stimulation when compared to control group. A significant increase in TLC is observed in stress + cold water vestibular stimulation and stress + hot water vestibular stimulation groups when compared to stress only group on 7th day. On 15th day, TLC increased in stress + cold water vestibular stimulation group and decreased in stress + hot water vestibular stimulation group. However, it is not statistically significant. The difference between stress + cold water vestibular stimulation and stress + hot water vestibular stimulation is statistically significant.
Liver weight increased significantly on 15th day in stress only group when compared with control group. Liver weight decreased significantly in stress + cold water vestibular stimulation and stress + hot water vestibular stimulation groups when compared with stress only group.

Spleen weight increased significantly on 15th day in stress only group when compared with control group. Spleen weight decreased significantly in stress + cold water vestibular stimulation and stress + hot water vestibular stimulation groups when compared with stress only group.

**DISCUSSION**

It was reported that hemoglobin levels increase significantly followed by cold water stress [17-19]. In the present study, we have observed a significant increase in hemoglobin levels in stress only group on 7th and 15th day. However, this increase is prevented in stress + hot water vestibular stimulation group. This effect may be due to inhibition of the effect of cortisol on the production of RBC [4].

We agree with the previous studies as we have observed a decrease in the TLC in stress only group on 7th day [20,21]. However, this decrease is not observed in both stress+ cold and hot water vestibular stimulation groups. This effect might be due to vestibular induced changes in adrenal steroids. Long-term applications of effects of hot and cold vestibular stimulation on TLC are different.

Neutrophil count increased significantly in stress only group is in accordance with previous studies [22]. However, in stress + cold water vestibular stimulation Neutrophil count is significantly less than stress only group.

Lymphocyte count decreased significantly in stress only group on 7th day is in accordance with previous studies [4]. This decrease might be due to inhibition of lymphocyte mitotic activity by glucocorticoids. This effect of stress on lymphocyte is minimum in stress + cold water vestibular stimulation group.

Glucocorticoids increases number of platelets in the circulation [4]. We agree with the previous studies as we have observed a significant increase in platelets on 15th day. However, platelet count was within normal limits in stress + cold water vestibular stimulation group.

It was reported that body weight increased significantly after 7 days of cold water swimming stress and no change after 15 days [14]. In the present study, significant increase in the body weight observed after 7 days and 15 days of cold water swimming stress in stress only group and body weight remain in normal limits in both hot and cold water vestibular stimulation groups. This effect may be due to the vestibular balance of food intake [2].

It was reported that liver and spleen weight increased significantly followed by cold water swimming stress [19]. We agree with the previous studies as we have observed a significant increase in the liver and spleen weight. No significant changes were observed in stress + cold and hot water vestibular stimulation groups.

**CONCLUSION**

Maximum effect of stress was observed on 7th day in stress only group whereas this effect is minimized in cold water vestibular stimulation group and maintained in normal limits thereafter. We recommend further detailed study in this area.

is considered for further detailed study.

**REFERENCES**


