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RESEARCH ARTICLE

Immediate effect of linear vestibular stimulation on blood pressure and pulse rate in healthy females

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ABSTRACT

Background: The physiological role of vestibular stimulation is not only confined to maintenance of balance but also in regulation of several body functions such as endocrine, autonomic, and cognitive functions. Vestibular system was reported to reduce the blood pressure with in normal limits by decreasing the sympathetic activity and increasing the parasympathetic activity. **Aims and Objectives:** The present study was undertaken to observe the immediate effect of linear vestibular stimulation on blood pressure and pulse rate in healthy females. **Materials and Methods:** A total of 15 female students studying 2nd year BDS were part of the study after obtaining the informed consent. The participants acted as self-control. Vestibular stimulation was administered by making the participants to swing on a swing according to their comfort in front to back direction. Blood pressure and pulse rate were recorded from the right hand using JSB digital sphygmomanometer. **Results:** There was a significant decrease ($P < 0.01$) in the pulse rate but remained in normal limits followed by the vestibular stimulation. Both systolic and diastolic blood pressure was reduced and remained in normal limits followed by vestibular stimulation. However, this decrease was not statistically significant. **Conclusion:** The study provides further evidence for autonomic modulation of vestibular stimulation. Hence, long-term practice of vestibular stimulation may have beneficial effects on autonomic functions.

KEY WORDS: Linear Vestibular Stimulation; Autonomic Functions; Pulse Rate

INTRODUCTION

Autonomic nervous system, which regulates various body systems and contributes to homeostasis. Autonomic nervous system, which is fundamental to systemic well-being, can, directly and indirectly, influence the immune function and stress response. Vestibular system comprises semicircular canals and otolith organs. It is located in the inner ear and it is one of the first sensory systems that start functioning before birth. The physiological role of vestibular stimulation is not only confined to maintenance of balance but also in regulation of several body functions such as endocrine, autonomic, and cognitive functions. In fact, vestibular system influences all the body systems.[1] Vestibular system was reported to reduce the blood pressure with in normal limits by decreasing the sympathetic activity and increasing the parasympathetic activity. The beneficial effects of vestibular stimulation observed on both direct and indirect measures of autonomic nervous system, indicate the involvement of several complex networks within the cortical regions of the brain such as hypothalamic paraventricular

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nucleus, rostral ventrolateral medulla, posterior hypothalamus, supracollicular, and/or locus ceruleus. The present study was undertaken to observe the immediate effect of linear vestibular stimulation on blood pressure and pulse rate in healthy females. This study measured the parameters such as systolic pressure, diastolic pressure, and pulse rate, which are well known to be directly regulated by autonomic nervous system.

MATERIALS AND METHODS

Study Design

The present study was experimental study. Blood pressure and pulse rate were recorded before and immediately after vestibular stimulation.

Study participants

A total of 15 female students studying 2nd year BDS were part of the study after obtaining the informed consent. Apparently healthy, willing participants were included in the study. The participants acted as self-control.

Study setting

The present study was conducted at the Department of Physiology, Vishnu Dental College, Bhimavaram.

Vestibular stimulation

Vestibular stimulation was administered by making the participants to swing on a swing according to their comfort in front to back direction.[2]

Recording of blood pressure

Blood pressure and pulse rate were recorded from the right hand using JSB digital sphygmomanometer.

Ethical consideration

The present study was approved by the institutional research committee.

Data analysis

Data were analyzed using SPSS 20.0. Data were expressed as mean and standard deviation. Student's *t*-test was used to observe the significance of difference between the groups. $P < 0.05$ was considered as statistically significant.

RESULTS

The results are presented in Tables 1 and 2. There was a significant decrease ($P < 0.01$) in the pulse rate but remained in normal limits followed by the vestibular stimulation. Both systolic and diastolic blood pressure was reduced and remained in normal limits followed by vestibular stimulation. However, this decrease was not statistically significant.

Table 1: Demographic data of the participants

Parameter	Mean±SD
Age (years)	18.86±0.2153
Height (cm)	161.90±1.6425
Weight (kg)	53.93±1.52
BMI (kg/m^2)	21.10±0.82

SD: Standard deviation, BMI: Body mass index

Table 2: Blood pressure and pulse rate before and after vestibular stimulation

Parameter	Before (*n*=15)	After (*n*=15)	*P* value
Systolic blood pressure (mmHg)	115.80±5.97	104.00±2.00	0.0716
Diastolic blood pressure (mmHg)	65.53±2.11	59.80±2.26	0.0742
Pulse rate (beats/min)	106.40±2.70	94.20±2.89	0.0046**

DISCUSSION

The present study was undertaken to observe the immediate effect of vestibular stimulation on autonomic parameters. There was a significant decrease in the pulse rate, but the blood pressure was not significantly changed. Maintenance of blood pressure was essential for survival as the vital structures like brain require continuous and adequate amount of blood supply. Further, regulation of blood pressure during change in the posture also very important to prevent the postural hypotension. Vestibular system was reported to regulate blood pressure through modulation of autonomic functions. It was reported that vestibular stimulation inhibits the stress axis and sympathetic adrenomedullary axis and decreases and keeps the autonomic parameters such as blood pressure and pulse rate.[3,4] Interestingly, it was reported that dysfunction of vestibular system causes impairment in the regulation of blood pressure.[5] Further, the improvement in autonomic parameters following vestibular stimulation may also involve medial cortical regions of lobules, cerebellum networks, uvula, posterior vermis, nucleus tractus solitaries (NTS), and dorsal motor nucleus.[6]

The support for the association of autonomic system with vestibular system is evident from the convergence of vestibular and baroreceptor signals on NTS neurons,[7] which is reported to positively modulate blood pressure and heart rate.[8] The results obtained from the present study are consistent with other studies reporting beneficial effects of caloric vestibular stimulation on sympathetic nerve activity, which can lead to decrease in blood pressure.[9-11] Transient changes in systolic blood pressure were also observed following linear vestibular stimulation in human subjects.[10] In similar lines, rotatory vestibular stimulation was reported to cause significant decrease in heart rate in children with Down's syndrome.[12] Such benefit on heart rate and blood pressure is also reported in human subjects following lateral

rocking movement[13] or conventional swing.[14] Contrary to this study results, 30 min of rocking was reported to increase both systolic and diastolic blood pressure in patients with Alzheimer's disease.[15] Further, a few studies have demonstrated that rotational vestibular stimulation alters respiration but not the cardiovascular parameters.[16] Such contrasting observations in other studies may be due to variations in the study subjects, compromised neural anatomy and physiology as a consequence to disease, and/or variations in the duration and nature of vestibular stimulation employed.

The role of sympathetic adrenomedullary axis in mediating the beneficial effects of vestibular stimulation is evident from studies reporting inhibition of paraventricular nucleus through gamma-aminobutyric acid (GABA).[17] Further, injection of GABA receptor antagonist into the posterior hypothalamus is reported to relieve stress-induced tachycardia and adrenergic response.[18,19] Furthermore, several vestibuloautonomic pathways are reported to be located from medial vestibular nucleus to the dorsal motor nucleus of the vagus nerve and the nucleus of the solitary tract.[8] Consequently, excitation of vagal efferent fibers is observed the following vestibular stimulation.[8] Thus, it is convincing that vestibular stimulation balances the autonomic activity through stimulation of parasympathetic nervous system and inhibition of sympathetic nervous system.[20] Stimulation of parasympathetic system and inhibition of sympathetic system decrease heart rate and respiratory rate. Decrease in the heart rate and respiratory rate sends signals to medulla and inhibits locus coeruleus and decreases norepinephrine availability to hypothalamus which intern secretes less corticotrophin-releasing hormone.[21] The present study results support the earlier studies as we have observed decrease in the autonomic activity followed by the intervention.

Limitations

The sample size of the study was small and the study included only female participants.

CONCLUSION

The study provides further evidence for autonomic modulation of vestibular stimulation. Hence, long-term practice of vestibular stimulation may have beneficial effects on autonomic functions.

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