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Effect of vestibular stimulation on stress and cardiovascular parameters in healthy college students.

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Abstract

Stress is a major public health problem, which affects most of the systems of the body. It was hypothesized that vestibular stimulation inhibits both the stress axis in direct and indirect ways and relieves stress. The current study aimed to provide further scientific evidence for soothing effects of vestibular stimulation and validate traditional knowledge to strengthen the basis for including vestibular stimulation as a life-style practice. 240 Healthy college students (120 males and 120 females) aged 18-24 years of either sex were included in this study after obtaining written consent from them. Vestibular stimulation was administered by making the participants to swing on a swing in back to front direction, according to their comfort, as per standardized methods. Assessment of stress was performed before and after intervention using stress questionnaire and measuring cortisol levels, blood pressure and pluse rate. Cortisol, stress score, pulse rate, systolic, diastolic, mean blood pressure were significantly decreased and remained in normal limits following vestibular stimulation. The present study provides evidence for beneficial effects of vestibular stimulation as an intervention for stress. Hence vestibular stimulation may be considered as a possible adjunctive therapy for those experiencing stress.

Keywords: Vestibular stimulation, Stress, College students.

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Introduction

Stress is a major public health problem, which affects most of the systems of the body [1]. Untreated stress leads to depression and adversely affects quantity and quality of life [2]. Mild form of stress may be beneficial, but persistently high stress is detrimental to mental health [3]. Indeed in a recent study, fifty percent of students were reported to have pre hypertension during regular classes [4]. Stress activates hypothalamic- pituitary-adrenal axis and increases secretion of cortisol. Measurement of salivary cortisol is a convenient and valuable alternative to measuring plasma cortisol levels as it is a non-invasive method and accurately reflects the free, biologically active cortisol levels in plasma. Moreover, salivary cortisol levels are not affected by salivary flow rate [3].

Many studies have highlighted the importance of a simple stress relief method, such as vestibular stimulation, as it easily fits our busy life style [5,6]. Vestibular system consists of sensory receptors, which are located in the inner ear and responsible for sense of equilibrium. Stress is regulated by two neuroendocrine axis; hypothalamic- pituitary-adrenal axis and sympathetic-adrenomedullary axis. Vestibular stimulation inhibits both the stress axis in direct and indirect ways and relieves stress [7,8]. Earlier studies reported that low frequency vestibular stimulation decreases cortisol levels significantly and prevents stress induced changes in the body [9-16]. Winter et al., reported that vestibular stimulation may cause pleasant and unpleasant mood changes depending on plane and axis of stimulation and translational vestibular stimulation causes relaxation and pleasure [17]. Swinging on a swing is a rhythmic activity, that stimulates vestibular system effectively [18-22]. Soothing effects of vestibular stimulation are culturally universal and well documented [18-20,22]. Swinging on a swing is fun and exciting and also provides soothing effects while preventing/curing many clinical disorders [18,20]. The current study aimed to provide further scientific evidence for soothing effects of vestibular stimulation and validate traditional knowledge to strengthen the basis for including vestibular stimulation as a life-style practice.

Research Methods

This experimental study was conducted at Department of Physiology, Little Flower Institute of Medical Sciences and Research Centre, and Little Flower Medical Research Centre, Angamaly, Kerala, India. The present study was approved by Institutional Human Ethical Committee of Little Flower Hospital and Research Centre, Angamaly, Kerala, India.

Written informed consent from was obtained from the participants.

Participants

240 Healthy college students (120 males and 120 females) aged 18-24 years of either sex participated in this research after obtaining written consent from them. Participants with drug/ alcohol abuse, and those taking any kind of medication or suffering from any somatic or mental disorders or ear infections or any vestibular disturbances, participants with a history of use of corticosteroids in the past year, students with a history of antidepressant medication, and students on hormone supplements including oral contraceptives and those with cardio-respiratory disorders were excluded. Selected participants were randomly assigned to four groups.

Group MC (n=60): Control male group (No vestibular stimulation was administered).

Group FC (n=60): Control female group (No vestibular stimulation was administered).

Group MV (n=60): Intervention male group (Vestibular stimulation was administered for 146 ± 5.6 days)

Group FV (n=60): Intervention female group (Vestibular stimulation was administered for 147 ± 6 days)

Vestibular stimulation

Vestibular stimulation was administered by making the participants to swing on a swing in back to front direction, according to their comfort, as mentioned earlier [23].

Outcome measures

All the parameters were recorded between 1 to 2 pm to minimize diurnal variation.

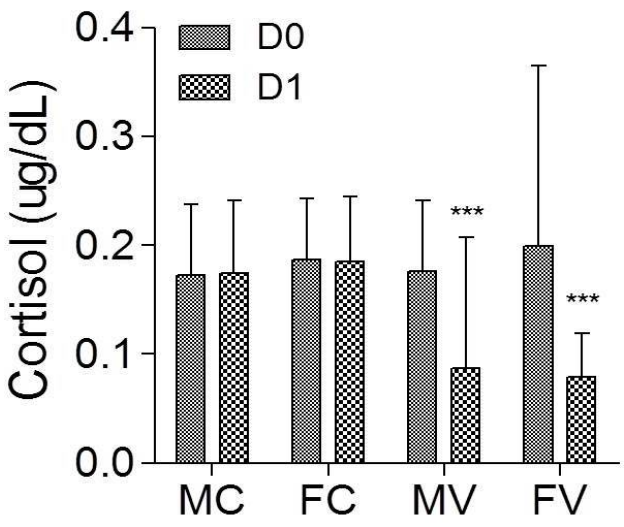

*Figure 1. Salivary Cortisol levels before and after vestibular stimulation in participants. (Data expressed are Mean ± SD) (*P value <0.05, **P<0.01, ***P<0.001). MV- Vestibular males, FV- Vestibular females, MC- control males, FC- Control females. D0- pre intervention score, D1- post intervention score.*

The students' stress questionnaire

Participants were given a questionnaire of 20 items for scoring stress scale. The questionnaire was available from public domain of (Ministry of Social Security, National Solidarity and Reform Institutions, (www.gov.mu/portal/sites/ suicideprevention/file/student) [13]. The psychological questionnaire was used in consultation with psychiatrist of our hospital.

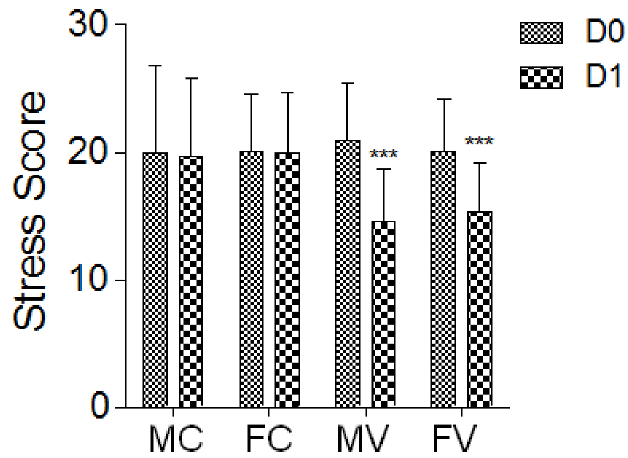

*Figure 2. Stress score before and after vestibular stimulation in participants. (Data expressed are Mean ± SD) (*P value <0.05,**P<0.01, ***P<0.001). MV- Vestibular males, FV- Vestibular females, MC- control males, FC- Control females. D0- pre intervention score, D1- post intervention score.*

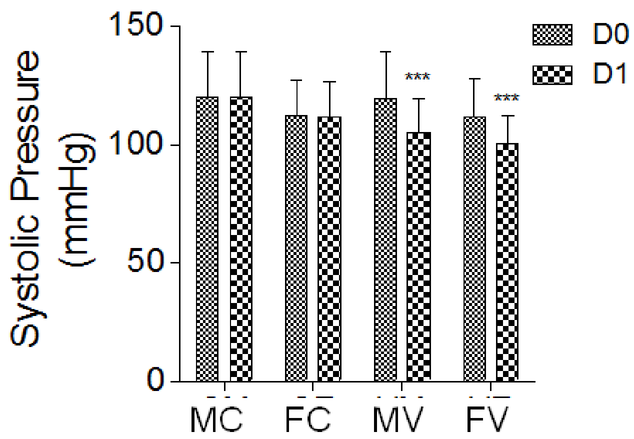

*Figure 3. Systolic blood pressure before and after vestibular stimulation in participants. (Data expressed are Mean ± SD) (*P value <0.05,** P<0.01, ***P<0.001). MV- Vestibular males, FV- Vestibular females, MC- control males, FC- Control females. D0- pre intervention score, D1- post intervention score.*

Salivary cortisol

Studies consistently report high correlations between serum and saliva cortisol levels, indicating that salivary cortisol levels reliably reflect serum cortisol levels [14,15]. Participants were instructed in advance not to drink or eat anything except water one hour before saliva collection to minimize interference of food debris and salivary stimulation. About 1 ml of unstimulated saliva was collected by saliva bio passive drool method following the standard guidelines provided by Salimetrics lab. Samples were stored at -20°C. Samples were analyzed by using Salimetrics assays, cortisol (expanded range) ELISA kit (saliva) 1-3002 in consultation with experts in the clinical lab. Same person who was blinded to the group performed ELISA of all the samples.

Pulse rate and blood pressure

Blood pressure was measured in the right arm in the sitting position by diamond digital blood pressure monitor-fully automatic M60, manufactured by Industrial Electronic and allied products. Pulse rate was recorded by using pulse oximeter.

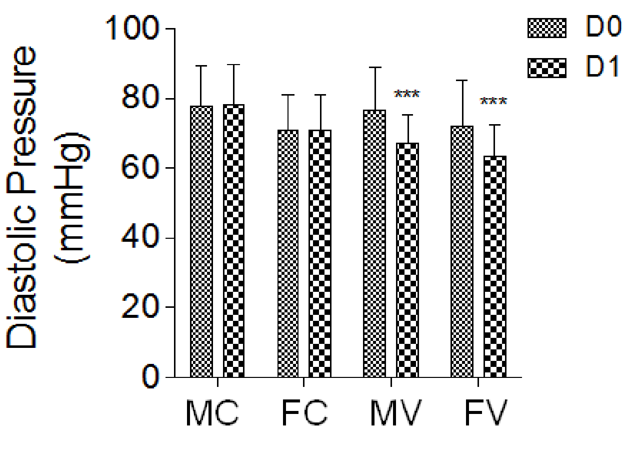

***Figure** 4. Diastolic blood pressure before and after vestibular stimulation in participants. (Data expressed are Mean ± SD) (*P value <0.05,** P<0.01, ***P<0.001). MV- Vestibular males, FV- Vestibular females, MC- control males, FC- Control females. D0- pre intervention score, D1- post intervention score.*

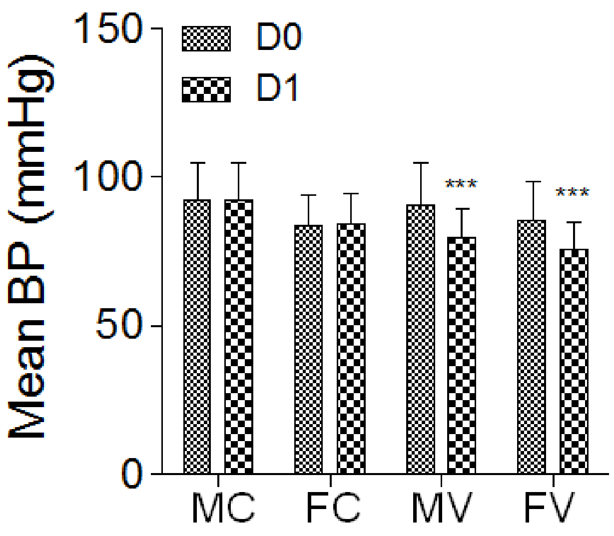

***Figure 5.** Mean blood pressure before and after vestibular stimulation in participants. (Data expressed are Mean ± SD) (*P value <0.05, ** P<0.01, ***P<0.001) MV- Vestibular males, FV- Vestibular females, MC- control males, FC- Control females. D0- pre intervention score, D1- post intervention score.*

Data analysis

Data analysis was done using the statistical software (SPSS version 20.0). All the data were expressed as Mean ± SD. Pre and post data were analyzed using two-way ANOVA followed by Bonferroni post hoc test to compare differences between groups. Probability value less than 0.05 ($P<0.05$) was considered significant.

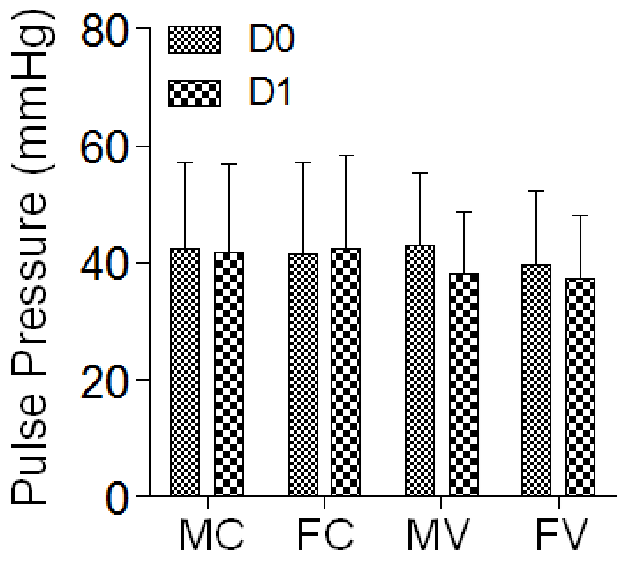

***Figure** 6. Pulse pressure before and after vestibular stimulation in participants. (Data expressed are Mean ± SD) (*P value <0.05, ** P<0.01, ***P<0.001) MV- Vestibular males, FV- Vestibular females, MC- control males, FC- Control females. D0- pre intervention score, D1- post intervention score.*

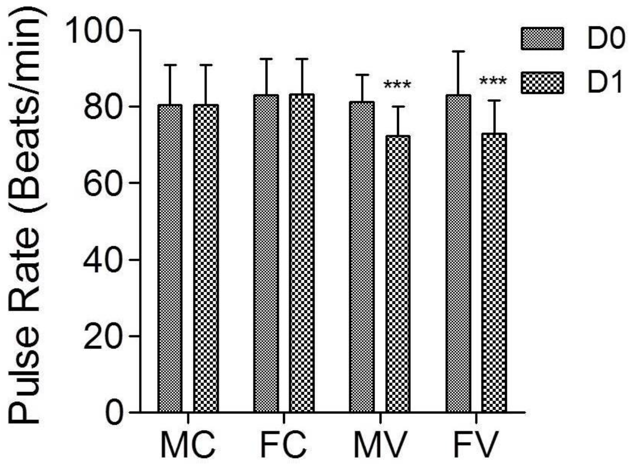

***Figure** 7. Pulse rate before and after vestibular stimulation in participants. (Data expressed are Mean ± SD) (*P value <0.05, **P<0.01, ***P<0.001). MV- Vestibular males, FV- Vestibular females, MC- control males, FC- Control females. D0- pre intervention score, D1- post intervention score.*

Results

Baseline values of cortisol, stress score and pulse rate, blood pressure were not significantly different between the groups. However, cortisol (P=0.001), stress score (P=0.0001), pulse rate (P=0.0042), systolic (P=0.0005), diastolic (P=0.0001), mean blood pressure (P=0.0037) were significantly reduced and remained within normal limits, following vestibular stimulation in VM and VF groups (Figures 1-7). Decrease in pulse pressure was not statistically significant.

Discussion

In the present study conventional swing was used to provide vestibular stimulation. We preferred to use vestibular stimulation by swing due to our previous experience and optimization of this technique. In the present study we have specifically looked at impact of stress on cardiovascular parameters. Vestibular stimulation may cause pleasant and unpleasant mood changes depending on plane- and axis of stimulation and translational vestibular stimulation causes relaxation and pleasure [17]. Which may be due to reduction in Cortisol levels following vestibular stimulation [12-14]. The soothing effects may be related to brainstem inhibitory mechanisms [24]. Indeed vestibular stimulation modulates HPA axis [8]. Vestibular stimulation may also inhibit HPA axis through release of GABA in substantia nigra and activation of hippocampal neurons [15,16]. Our results are in accordance with these earlier studies as we observed significant decrease in student stress scores, cortisol levels to within normal limits, following vestibular stimulation.

Vestibule-sympathetic reflex plays a key role in gravitational adaptation [25]. It was reported that electrical or natural stimulation modulates blood pressure and respiratory motor output and maintains homeostasis [26,27]. Vestibular stimulation is consistently found to reduce blood pressure by reducing sympathetic activity [28]. Vestibular stimulation activates lateral and ventrolateral subnuclei of the nucleus tractus solitarii (NTS), where the first synapse of the carotid sinus baroreflex is located. Activation of NTS inhibits rostral ventrolateral medulla, where sympathetic activity is thought to be mainly controlled [28-30]. Further it is also reported that blood pressure was lowered following caloric and rotational vestibular stimulation and this effect was abolished in presence of vestibular lesions [31-33]. Vestibular stimulation activates parabrachial neurons, which has profound effects on autonomic functions [34]. In our study systolic, diastolic and mean blood pressure were significantly lowered to within normal limits, following vestibular stimulation. This may be due to autonomic balancing effects of vestibular system. In contrast, Costa et al., failed to observe sympathetic withdrawal effects following vestibular stimulation [35]. Sandra et al., administered programmed vestibular stimulation to two children with Down's syndrome and reported that both of them responded physiologically to stimulation and their heart rate decreased to within normal limits [36]. In contrast, Oh et al., reported that heart rate was increased following vestibular stimulation in anesthetized rabbits [37]. Tian et al. reported that heart rate can be increased or decreased following vestibular stimulation. However, the change in heart rate depends on the intensity of the stimulation [38]. Our results further supports Tian et al., study as we have observed significant decrease in the pulse rate. In our study the intensity and frequency was according to the comfort of the participants, this may be the cause for decrease in heart rate.

Limitations

We could not exclude the effect of movement activity and norepinephrine release on the evaluated indices, as we have no suitable control group for this purpose. Hence the findings from this study should be interpreted considering these limitations.

Conclusion

The present study provides further evidence for beneficial effects from the use of vestibular stimulation as an intervention for stress. Hence vestibular stimulation may be considered as a possible adjunctive therapy for those experiencing stress.

Acknowledgement

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