ORIGINAL ARTICLE

ASSESSMENT OF EFFECTS OF SYMPATHETIC NERVOUS SYSTEM WITH EVOKING ACUTE MENTAL STRESS ON THE 1ST YEAR BDS STUDENTS BY A SURPRISE VIVA EXAMINATION

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Background: Academics and examinations are a source of stress among students which is much greater among medical and dental professional students. The objective of this study was to assess the effects of sympathetic nervous system by evoking acute mental stress on the 1st year BDS students by taking a surprise viva test in the subject of physiology. **Methods:** This observational study was carried out in the Physiology Department of Fatima Jinnah Dental College on 28th March, 2018. A total of 66 healthy students were included in this study. Mental stress was evoked by announcing a surprise viva test of physiology. Their baseline and pre-viva pulse and blood pressure were recorded and compared. Paired sample *t*-test was applied to check the statistical significance of differences between baseline and pre-viva blood pressure and pulse of 66 participants. **Results:** Out of 66 healthy students, 43 (65.2%) were females, and 23 (34.8%) were males. The mean pre-viva pulse of participants was significantly higher than the mean baseline pulse with a *t*-value of -8.455 (df=65) ($p<0.001$). Mean pre-viva blood pressure was found to be significantly higher than the mean baseline blood pressure (*t*-value -2.370, df=65) ($p=0.021$). **Conclusion:** Acute mental stress stimulates sympathetic nervous system by increasing the heart rate and blood pressure that is needed to prepare an individual to face any challenge or a threat.

Keywords: Sympathetic nervous system, Stress, Blood pressure, Heart rate
Pak J Physiol 2020;16(4):33–6

INTRODUCTION

It is a well-known fact that academics and examinations are a source of stress among students which is much greater among medical and dental professional students.[1] Stress is sensed as a threat to homeostasis and the specific response to stress depends upon the individual's perception, external and internal triggers of stress and the ability to cope with it. Medical and dental students are exposed to different types of stresses during the course of their academic lives. These short term acute triggers of stress include new curriculum, new college environment, regular assignments, theory and *viva voce* examinations which keep on testing their understanding of knowledge that is actually needed to transform them into professional, educated and responsible dentists of the society.

Human body has many homeostatic control systems. Acute stress is the state that lasts for minutes to hours. The acute mental stress is evoked by the stress system which is situated partly in the central nervous system and partly in the peripheral nervous system.[2] The fundamental pathways that are triggered by acute mental stress are the autonomic nervous system and the hypothalamic-pituitary-adrenal axis.[3] Neuroendocrine hormones play a major role in the control of both basal homeostasis and in responses to threats. Psychological stress triggers the activation of sympathetic nervous system and causes norepinephrine release.[4] Sympathetic nervous system is a part of autonomic nervous system. The autonomic nervous system is interlinked with the endocrine system.[5] The autonomic nervous system exerts a major part in the control of homeostasis. This system acts without conscious sense as it supplies cardiac muscles, smooth muscles and many endocrine and exocrine glands.[6] This sympathetic nervous system responds to a challenging or stressful situation of individuals by increasing the blood pressure and heart rate. Sympathetic nervous system enhances the blood flow to the heart, brain and skeletal muscles, diverting the blood flow from the skin and other organs to help in fight or flight response at the time of acute mental stress.

The sympathetic nervous system stimulates the adrenal medulla to release epinephrine and norepinephrine which cause systemic arteriolar constriction and that increase the total peripheral resistance and hence raise the blood pressure. The veins are also constricted which force more blood to flow towards the right side of the heart increasing the venous return. Consequently, this increases the cardiac output and the cardiac contractility. Heart is also directly stimulated to beat faster due to reciprocal inhibition of parasympathetic vagal activity. As a result, the heart rate is accelerated. So there is simultaneous stimulation of vasoconstrictor and cardio accelerator function of sympathetic nervous system. During stress and frightful situations, heart rate and blood pressure sometimes become as high as double the normal and this change rapidly occurs within 5–10 seconds. Sympathetic stimulation also causes other changes in the body like

dilatation of pupils, decreased salivation, stimulation of sweat gland, dilatation of bronchi and muscle contraction.[7]

Cortisol secretion is increased from adrenal cortex during stress. It increases the glucose concentration in the blood that is needed to the brain for increasing mental activity in stressful situations. Cortisol plays an important role in adaptation of stress. Cortisol secretion is controlled by hypothalamus that secretes corticotrophin releasing hormone. It in turn stimulates anterior pituitary gland to release adrenocorticotrophic hormone (ACTH) which stimulates adrenal cortex to release cortisol.[8] The sympatho-excitatory pressor effects are later buffered by the arterial baroreceptors which bring down the arterial pressure and heart rates towards normal, once the stressful response is over to achieve homeostasis.[9]

Academic stress can be applied as a good model of a natural stress among students. During viva test, this acute stress is evoked that triggers the sympatho-adreno-medullary, sympatho-neural and brain catecholaminergic system. It causes increase in cardiac output, blood pressure and heart rate which can be recorded objectively.

Minimal stress is important to keep the students follow their time table of regular studies so that they remain prepared for the exams. Excess or continued stress is detrimental. As the viva tests are routinely applied, so the students become used to the oral exams and cope better during final examinations. It is also observed that extra-curricular activities and sports help in alleviating stress so physical relaxing activities should be a regular feature to overcome academic stresses.[10] The objective of this study was to assess the effects of sympathetic nervous system by evoking acute mental stress on the 1st year BDS students with taking a surprise viva examination of physiology.

METHODOLOGY

The data for this one-day observational/cross-sectional study was collected from the 1st year BDS students of Fatima Jinnah Dental College in the Physiology Department on 28st March 2018. Inclusion criteria was to induct healthy males and females of 1st year BDS of age 18–20 years. For this study permission was granted by the ethical review board committee of Fatima Jinnah Dental College after approval of the synopsis. When Students arrived in the lecture hall for a routine morning lecture, they were made to be seated in four rows and informed consent was taken from all the students that they were undergoing a study procedure instead of the lecture. Four demonstrators were assigned, one for each row to record base-line pulse, temperature and blood pressure by automated apparatus.

When 16 students in first row were completed, they were sent to another room where the Head of Department announced a surprise viva test, followed by viva. Viva is a form of oral exam in which the examiner asks questions to the student in spoken form. The student has to answer the questions in such a way as to convince the examiner that they have good comprehension and knowledge of the subject to pass the test.

Their pulse and blood pressure were again checked after the announcement of viva test, prior to the viva, and recorded. Time elapsed between the two recordings was 5–15 minutes. Other three rows similarly followed the same procedure and their base line and pre-viva pulse, temperature and blood pressure were recorded. After the viva, students remained in the adjacent room until viva was completed for all of them and then they were off together. Students with normal haemoglobin levels were inducted in this study. The students having baseline tachycardia or bradycardia, anaemia, fever or having enlarged thyroid glands were excluded. Temperature was noted to exclude fever. Haemoglobin levels of these students were checked in the previous practical in the physiology lab. These baseline and pre-viva readings of pulse and blood pressure were compared and the data were analysed using SPSS-16.

RESULTS

Out of 66 healthy students, 43 were females (65.2%) and 23 were males (34.8%). Their baseline pulses were recorded to be minimum of 61/min and maximum of 90/min with the mean value of 79.92/min with standard deviation of 6.439. Their pre-viva (after exposure of acute mental stress) pulses recorded to be of minimum of 68/min and maximum of 153/min with the mean value of 104/min with standard deviation of 14.033. Their base line systolic blood pressure was found to be minimum of 90 mmHg and maximum of 136 mmHg with the mean vale of 116 mmHg. Their pre-viva (after exposure of acute mental stress) systolic blood pressure recorded to be minimum of 101 mmHg and maximum of 158 mmHg with the mean value of 133 mmHg and standard deviation was found to be 9.89. Their temperature was normal and so do their haemoglobin levels that was the inclusion criteria.

We applied the paired sample *t*-test to check the statistical significance of differences between baseline and pre-viva blood pressure and pulse of 66 participants. We found that the mean pre-viva pulse of participants was significantly higher than the mean baseline pulse with a t-value of -8.455 (df=65) and a $p<0.001$. Mean pre-viva blood pressure was found to be significantly higher than the mean baseline blood pressure with a *t*-value of -2.370 (df=65) and a $p=0.021$.

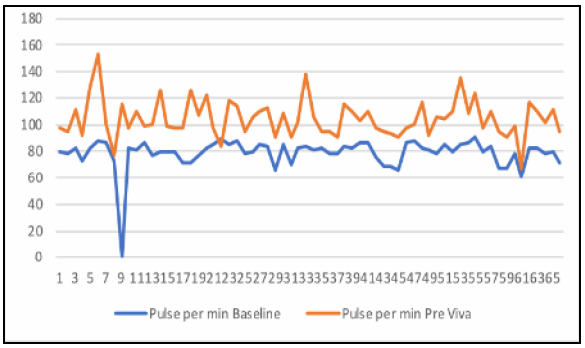

Figure-1: Pulse per min pre-viva

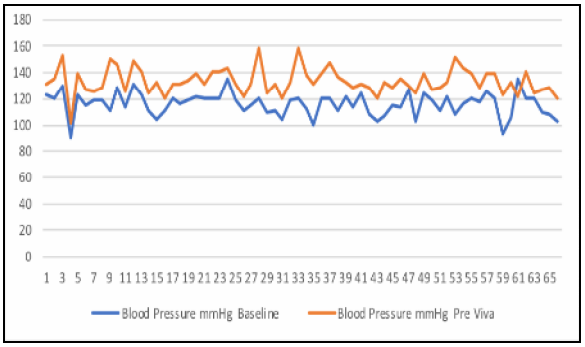

Figure-2: Blood pressure (mmHg) pre-viva

DISCUSSION

In this study the effects of sympathetic nervous system were demonstrated by evoking acute mental stress on 1st year BDS students by taking a surprise viva test. Stress occurs when homeostasis is threatened. Stressful stimuli bring about complex endocrine, autonomic and behavioural responses. This complex consists of sympathato-adreno-medullary, sympatho-neural and brain catecholaminergic system. Although the sympathetic nervous system brings about many changes in the body beside increasing the heart rate and blood pressure, i.e., dilatation of pupils, dilatation of bronchi, stimulation of sweat glands, and contraction of muscles. But we quantified only two objective findings of increase in blood pressure and the heart rate in the present study. Whenever there is any threat or dangerous situation, human body reacts by activation of sympathetic nervous system which releases catecholamine, epinephrine and norepinephrine by the adrenal medulla. Norepinephrine is also released as a neurotransmitter by the sympathetic nerve endings. Hypothalamic pituitary adrenal axis also responds through corticotrophin releasing hormone (CRH) from hypothalamus and adrenocorticotrophic hormone (ACTH) from anterior pituitary which in turn releases cortisol by adrenal cortex.[11]

Adrenal medulla and sympathetic nervous system act together. Anxiety and fear play major role to evoke nonspecific responses on exposure to different stress factors.[12] In a study carried out by David K. Sherman *et al*[13] found that students' morning urine samples on the most stressful examination had increased levels of epinephrine. Bruce S McEwen[14] also demonstrated cardiovascular stress responses on exposure of stressful arithmetic test. He also found out that ambulatory blood pressure is increased during stress in everyday life. Psychological stress stimulates sympathetic nerves to the heart and triggers epinephrine release. This increases the blood pressure and oxygen consumption by the heart. Psychological stress affects the heart in multiple ways. Stress accelerates the heart rate by withdrawing the parasympathetic pathway and increasing the sympathetic output.[15]

In a similar study, Durocher JJ *et al*[15] hypothesised stimulation of sympathetic nervous system during mental stress. They found that heart rate and arterial blood pressure are consistently raised by sympathetic stimulation. Koelsch *et al*[16] reported that acute stress stimulates stress response by triggering sympathetic activity and hypothalamic pituitary adrenal axis activity and increase the concentration of cortisol in the blood. Carrillo AE *et al* found that changes in the heart rate is a sensitive and non-invasive tool to estimate the time difference between consecutive heart beats to evaluate autonomic nervous system modulation.[17]

Michael Trapp *et al* also carried out a study and their results showed that combined mental and physical stress causes a significantly higher raise in blood pressure and pulse pressure.[18] Jawwad G *et al*[19] also reported that stress results in raised blood cortisol concentrations in the morning and also brings about changes in the autonomic nervous system that can be evaluated by measuring changes in the heart rate. Arterial baroreceptor reflex is the fundamental short-term regulator of blood pressure and once the sympathetic nervous system stimulation increases the blood pressure by systemic vasoconstriction on exposure to acute psychological or mental stress, this baroreceptor reflex mechanism brings down the blood pressure again to achieve homeostasis.[20] The mathematical conversion of heart rate variability into power spectral density is commonly applied as a non-invasive test of neuroendocrine function as it can differentiate sympathetic from parasympathetic control of the heart rate. So heart rate variability recordings can be used to study the function of autonomic nervous system.

CONCLUSION

Acute mental stress stimulates sympathetic nervous system by increasing the heart rate and blood pressure that is needed to prepare an individual to face any challenging situation or a threat. Both blood pressure and pulse levels of participants were significantly higher in pre-viva situation compared to the baseline.

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Received: 8 Nov 2018 **Reviewed: 22 Dec 2020** **Accepted: 22 Dec 2020**

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ZH: Concept, Study design, Data collection, Manuscript writing, Revision
MA: Data collection and analysis, Revision
HI: Data collection and analysis
FZ: Data collection and analysis, Literature search
GM: Tabulation, Literature search

Funding disclosure: None to declare
Conflict of interest: None