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Research Article

Valsalva ratio: a measure of stress in first year medical students

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ABSTRACT

Background: The Valsalva manoeuvre is commonly used as a method of assessing normal or disordered Autonomic control of Blood pressure and Heart Rate. Continuous changes in sympathetic and parasympathetic neural inputs exhibits alteration in Heart Rate and blood pressure which causes oscillation of R-R interval. Acute and short term stress leads to rapid changes throughout the body. Almost all body system gear up to meet the perceived dangers (stress).When healthy subjects are acutely stressed Heart rate increases and R-R interval on ECG decreases transiently. The purpose of the study is to see the changes in VMM in prestress and stress conditions.
Methods: 56 non-smoking apparently healthy first year medical students (26 males and 26 females) were selected for the present study. Data collected two month prior to the examination as prestress values and during examination as during stress values. Data analyzed using Wilxcon Rank signed 2 tailed test and the sub groups data analyzed paired t test.
Results: 11.54% males and 19.23% females had mild stress in prestress condition. During stress 46.15% males and 19.23% females had mild stress while 34.62% males and 57% of females had severe stress. The female had more stress as compared to males both in prestress and during stress conditions.
Conclusion: We conclude that VR is affected by the academic stress in the first year medical students and that among them females are more affected which may be due to the new environment and new protocol of the education system.

Keywords: Valsalva Weber manoeuvre, Stress, Valsalva Ratio, Cardiovascular reflex, Heart rate, Blood pressure

INTRODUCTION

Valsalva Ratio is a measure of the Heart Rate response to Blood pressure changes resulting from the mechanical and cardiovascular effects of the Valsalva manoeuvre.[1] This method explores cardiac autonomic control based on tachycardia and bradycardia response to sudden short – lasting subsequent and alternating induction and liberation of forced expiration against standardized resistance, resulting in an abrupt reduction and elevation of arterial pressure respectively.[2] It evaluates the integrity of cardiac autonomic function based on heart rate responses associated with the arterial pressure stabilizing baroreflex mechanism.

During academic stress the sympathetic activity is increased. The estimated prevalence of emotional disturbance was found in different studies higher than in general population.[3] Medical education poses many new challenging and potentially threatening situational demands as the incoming students throughout the world. An optimal level of stress enhances learning skills while excess of stress can cause health problems and decrease academic performance. The young medical students' population is vulnerable to stress in higher professional education due to competitive environment. Acute and short term stress leads to rapid changes throughout the body. Almost all body system gear up to meet the perceived danger (stress). Continuous changes in sympathetic and parasympathetic neural inputs exhibits alteration in heart rate and causes oscillation of R-R interval around its mean value. One of the most simple and global measure of Heart Rate Variation (HRV) is standard deviation of mean R-R interval in ECG. When

healthy subjects are acutely stressed Heart Rate (HR) increases and R-R interval on ECG decreases transiently.[4,5,6] Only a few studies have investigated the impact of acute stressor on various HR complexity measures in healthy individuals.[7,8]

It was shown in healthy young subjects that short term psychological stress was associated with both decrease and increase in heart rate complexity (that is normalized entropy) regardless of type of stressors such as Noise exposure, exam stress etc.,[8]

Under normal condition the Heart rate generating system fluctuates between a set of metastable states or attraction ready to adapt to internal or external challenges of an ever changing environment.[8,9]

Thus reduction in Heart rate complexity during stressful condition may represent a lower adaptability and fitness of the cardiac parameters and a functional restriction of the participating cardiovascular elements. The complex phenomenon of Heart rate control may represent activation of Autonomic Nervous System and Renin Angiotensin System well as other feedback system.

Thus decrease in Heart rate in response to short term stress is due to sympathovagal imbalance characterized by decrease in PNS activity and relative increase in SNS tone.[4]

Valsalva manoeuvre

Brief history: Antonio Maria Valsalva described in detail the procedure that we perform today.[11] It was Worthington who credited the first description of a manoeuvre of forced expiration against the glottis, with mouth and nose closed, with the objective of diagnostic or discharge fluids of a fractured skull.[2] Later it was German Physiologist Edward Weber who detailed cardiovascular alteration associated with the manoeuvre allowing its use for diagnostic or investigative objectives.[12,13]

Hence the Valsalva manoeuvre is either therapeutic or diagnostic elucidation or to demonstrate functional mechanisms as in heart clinical examinations and investigations of cardiac autonomic function. Alternatively with the aim of simplification, correction and justice it would be preferable to call the procedure more appropriately as Valsalva-Weber manoeuvre (VWM).

Hamilton et al characterized the manoeuvre as consisting of four phases of cardiovascular changes reflecting simultaneous arterial pressure modifications and heart rate reflex response.[14] Rushmer introduced the objective measure of the intraocular pressure generated by the expiratory straining during the manoeuvre using the mercury column BP apparatus.[13]

Although the interpretation of the existing normal or impaired functional status is complex, the Valsalva – Weber manoeuvre (VWM) is a very simple procedure to carry out noninvasively by recording the ECG lead II. This is associated with transient cardiovascular changes, autonomic activity modifications, and Intrathoracic, intrabdominal and intraocular pressure increase.[12,10,14,15,16]

The VWM is a measure of the HR response to BP changes resulting from the mechanical and cardiovascular effects of the VWM. By increasing Intrathoracic and intrabdominal pressure, the straining results in decrease in the venous return of blood to the heart with an increase in venous pressure, progressive arterial pressure reduction, this results in a progressive compensatory baroreflex-mediated heart rate increase. Following cessation of the straining phase, these functional changes are abruptly reversed, resulting in an overshoot of arterial pressure that is accompanied by a rapid progressive baroreflex bradycardia lasting some seconds until the return of blood pressure and heart rate to basal levels.[2,12,9,15,16,17] VWM consists of four phases, designated I to IV, which delineate the cardiovascular changes during the VWM. Phase I consists of a transient rise in BP with a variable bradycardia that results from the increased Intrathoracic and intrabdominal pressures. During Phase II, there is a fall and recovery of BP with an incremental relative tachycardia. During Phase III there is further decrease in BP with progression of the tachycardia to the maximum level caused by the release of Intrathoracic pressure. During phase IV, there is an overshoot caused by the increase cardiac output into a vasoconstricted peripheral circulation with onset of progressive relative bradycardia in response to the rapid arterial pressure overshoot, which lasts for few seconds until there is complete recovery.

As the BP falls in phase II, there is an increase in HR caused by the Parasympathetic withdrawal that is followed by sympathetic activation. This results an increase in HR during and shortly after the VWM. In response to the BP overshoot during phase IV, approx 15-30 second after the end of the VWM ,the HR falls and produces a transient bradycardia that persists, in the normal state, until after the BP overshoot. This results in minimum HR. The Valsalva Ratio (VR) is calculated as the maximum Heart Rate (max HR), which occurs during or shortly after the VWM, divided by the minimum Heart Rate (min HR), with the cessation of the VWM. (VR=max HR/min HR). A normal Valsalva Ratio (VR) reflects intact Baroreceptors –mediated rise and fall in HR. The reduced VR value reflects Baroreceptors and cardiovagal dysfunction.

VR: stimulus: expiration of 40 mmHg for 15-20 seconds

Afferent: Baroreceptors, IX and X cranial nerves,

Centre: Nucleus tractus solitarius

Efferent: X CN and Sympathetic NS

Response: HR response to BP changes and fall and rise in blood pressure (phase I to IV).

The stress scoring of VR on basis of VWM is as follows: ≥1.21-→normal, 1.11-1.20→mild stress and ≤1.10→severe stress.

Heart rate responses to the VWM are the result of the reflex mechanism, predominantly of Baroreceptors origin, which involve mainly parasympathetic but also the involve Sympathetic nervous system as mentioned earlier. Cardiopulmonary and chemoreceptor reflexes appear to be involved to a lesser extent, interacting with the baroreflex. The phase III to I progressive bradycardia that follows the liberation of straining is thought to be due to Parasympathetic Nervous System activation alone[18,19,20,21,22,23]

Hence the quantification of the heart rate associated with the VWM has been used as a sensible, reliable, reproducible and very simple method for characterizing the suddenly acting cardiac autonomic modulation.

Although the VWM very uncommonly results in undesirable effects hence the basic physiological parameters must be examined. Potential adverse events could include Retinal haemorrhage, urinary incontinence, syncope, chest pain, arrhythmias, severe hypertensive or hypotensive reactions, or cerebral stroke. For more precise functional evaluation, the VWM should be performed at least 3 times and the average or highest value can be considered.[2]

The present study was done to illustrate the relation between academic stress and Valsalva ratio in First year medical students.

METHODS

56 non-smoking apparently healthy First year medical students of either sex (26 numbers) were selected in the present study after obtaining written informed consent to a protocol that was approved by the institutional Ethic review board of BLDEA's Shri B.M.Patil Medical College Bijapur, Karnataka. Those students who were not taking any sort of drugs or treatment, or form of tobacco, and were not having any link of cardiovascular disorder as assessed by detailed history and thorough physical and clinical examination were selected for our study. Prior to participation, the potential risks and benefits of the research study were explained to all the students.

Base line parameters like anthropometric and physiological were recorded before start the study.

Valsalva Weber manoeuvre (VWM): The VWM is a measure of change of heart rate that takes place during a period of forced expiration against closed glottis or mouth piece. The VM is performed with a subject seated after 15-30 minute rest. The subject sits is an erect posture in a chair with rubber clip over nose, and resting ECG recorded for 15 seconds. In lead II. Later, the subject is asked to blow mercury manometer upto 40mmHg and maintain the 40mmHg column for 15 seconds by continued blowing into mouth piece connected to mercury Bp apparatus. A continuous ECG recording was done during and 15 second following the VM. The result expressed as

VR= Longest RR interval after VM/Shortest RR interval during VM

For every student 3 readings were taken. The average of 3 was considered for further analysis .the V M was recorded twice. First reading was two month prior to academic examination as Prestress (PS) reading and second reading during the examination (written and vivavoce examination) recorded as during stress (DS).The values were compared with stress scoring ≥1.21 as Normal (Eustress), 1.11-1.20 as mild or borderline stress and ≤1.10 as severe stress.

RESULTS

Data analyzed by using Graph pad Instat 2 software.

Student's t test for paired samples was used to compare the main value of the study variable in relation to stress as prestress (PS) and during stress (DS).The Descriptive statistic like Mean, Std deviation, SEM and Pearson's coefficient of correlation among different study variable was also calculated. Value < 0.05, <0.01 and <.001 were considered as significant, highly significant and extremely significant values.

Table 1 shows the descriptive statistic where the Mean VR in male and female is during stress is 1.18 (±0.27 SEM 0.053) and 1.173(±0.36 SEM0.071) respectively. The values are lower than that is Prestress condition and statically extremely significant.

Table 1: Shows the descriptive statistics in male and female during prestress and during stress condition.

VMM	Prestress	During stress	Prestress	During Stress
	Male		Female	
Mean	1.48	1.18	1.51	1.17
Std Dev	0.27	0.17	0.36	0.2
SEM	0.05	034	0.071	0.04

Table 2 shows comparison of prestress and during stress values in males and females by Wilcoxon signed Rank test (two tailed). It was observed that male had Z values =-3.52(meandff0.41 critical W for N=26 at P value, 0.01 to be 68 and P value obtained was 0.00044.

In female medical students Z values was -3.59 (mean dff =0.46) critical W for N=26 at p<0.01 to be 75 with p value 0.00034.

Table 2: Comparison of Prestress and during stress VMM in male and female Wilcoxon signed Rank test (two tailed paired test).

VMM	Mean diff	Mean (W)	Std Dev (W)	Z value	Critical W At P<0.01	P value
Male	0.41	162.5	37.17	-3.52	68	0.00044
Female	0.46	175.5	39.37	-3.59	75	0.00034

Table 3 shows the percentage and number of students in Eustress, mild and severs stress condition.

Table 3: showing the number and distribution of the male and female students depending on Eustress, borderline (mild) and severe stress.

Stress score	Male		Female	
	Prestress % (no.)	During stress % (no.)	Prestress % (no.)	During stress % (no.)
≥1.21 (Normal)	88.46 (23)	19.23(5)	80.77 (21)	23.08(6)
1.11-1.20 (Mild)	11.54 (3)	45.15 (12)	19.23 (5)	19.23(5)
≤1.10 (severe)	0(0)	34.62(9)	0(0)	57.69 (15)
Total	100 (26)	100(26)	100(26)	100(26)

It was observed that 88.46% (23) male and 80.77 %(21) females were in Eustress in Prestress condition. It was observed that 11.54% (3) males and 19.23% (5) females had mild or borderline stress and none of them had severe stress in prestress condition. While it reflected from during stress observation that major students population that is 46.15% (12) of males and 19.23%(5) of females had mild or borderline stress while 34.62% (9) of male and 57%(15) of female suffered from extreme stress.

DISCUSSION

The stress level was tested VR by using VWM. Wilcoxon sign *r*ank two tailed test and student's t test were used to test the significance. In the present study there was extremely significant different in VM.ratio.in both male and female medical students due to academic examination stress. The female students had more stress as compared to male students and also that it was seen in prestress condition also. A research reported similar findings by Srinivasan et al[24] suggested altered autonomic homeostasis with a shift towards sympathetic activation and Vagal withdrawal. The present study finding and above author findings are in agreement with an earlier studies on the affect of acute in healthy young medical undergraduates by Malliani.[25] Some studies suggest that mental health worsens after students take admission to medical schools and remains poor through the training especially in the transition from basic science teaching to the clinical training.[26,27]

In another studies by Hamza et al and Guthrie et al showed that students found medical course stressful during first year but not in the subsequent years. This could be students may be able to develop coping mechanisms with the help of student support system and get used to environment and pattern of curriculum.[28] A Study from UK showed that one third of psychiatrically ill students did not complete their education. The changes appear to be significant during the first year of course. Hence early detection of mild to severe stress among the students and with effective psychological services and aids may prevent illness in future.[28] The overall mean perceived stress was significant among female students. In agreement with previous reports, majority of the students reported the academic demands of the medical training during first year as an important source of stress. It is noted in the present study that there was extremely significant difference in VR in both male and female student groups. The female students had more stress as compared to the male medical students. A recent research reported similar findings by Mohsin S et al.[29]

Various studies confirmed that there is a considerable amount of stress among the medical students which is common and process oriented.[30,31,32]

Steenberger et al and Ronald BW noted that females have reported exams as the reason for their stress than their male counterparts.[33,34]. Mamoza MA obtained the response of stress by confirming the higher prevalence of stress in undergraduate medical students.[35] Stowell had revealed that the stress level in medical students is increased during the academic examination and labelled as academic examination.[36] Balkishan Sharma et al observed in their study that the mean stress score index for males was 56.21+-12.77 and for females was 57.65+-12.04.[37] He also observed that the stress score was more in females as compared to males.[37] Mohamad Saiful Bahri Youff et al observed in the similar study that prevalence of stress among the first year medical students in school of Medical sciences university Sain Malaysia was 29.6%.[38] Hamza Mohammad Abdulgani in his cross sectional study found the prevalence of stress as high as 74.2% in first year medical students, which he found to be higher as compared to the other years of medical students.[28]

CONCLUSION

From the present study it could be concluded that VR is affected by the academic (examination) stress in the first year medical students and the female medical students are more affected than the male medical students. The mild stress was also in small percentage of male and female students in pre stress condition may be due the new environment and new protocol and method of the study.

Limitation of the study

The present study did not analysis the haematological parameter to assess the stress level. The study is also done in first year students and did not compare with other

Para and clinical students to know the stress levels at different academic years.

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