How to Cite:
Zafar, U., Khan, S., Raza, S. S., Zafar, N., Sajjad, S., & Ali, D. E. S. (2022). Stress related changes due to valsalva maneuver in healthy young individuals of Khyber Pakhtunkhwa. *International Journal of Health Sciences*, *6*(S5), 11651–11658. https://doi.org/10.53730/ijhs.v6nS5.12014

Stress related changes due to valsalva maneuver in healthy young individuals of Khyber Pakhtunkhwa

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***Abstract*---**Background: Effect of stress application on the body in particular, one that raises the intrathoracic pressure, like the Valsalva Maneuver needed to be gauged in the population of Khyber Pakhtunkhwa. The aim of this research was to assess the changes induced by Valsalva manoeuvre on the body depicted via an ECG. Methods: It was a cross sectional study conducted on healthy young adults in the research laboratory of the physiology department, Khyber Medical College over a period of seven months. A total of 119 subjects were included in research, those with morbidities were excluded. The rest were made to perform the Valsalva manoeuvre for 15 seconds at maintaining pressure of 40 mmHg. The blood pressure, ECG and heart rate were measured during and after the procedure. The data was then analysed using SPSS version 26.0. Results: The significantly affected parameters by stress were blood pressure PR, RR, QT intervals and T wave. The changes in the parameters, at rest, were either insignificant or were differentially significant in both the genders. Conclusion: Valsalva manoeuvre has a direct effect on blood

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2022.
Manuscript submitted: 9 April 2022, Manuscript revised: 18 June 2022, Accepted for publication: 27 July 2022

pressure and ECG and in turn on pumping of the heart via effecting the ventricular contraction and repolarization.

***Keywords*---** ECG, stress, Valsalva maneuver, blood pressure.

Introduction

Valsalva maneuver (VM) is a forced expiration of a subject against a resistance; that is a closed glottis and it can be used to judge the functioning of baroreceptors. It has four phases. [1] During phase II of VM the pressure inside the chest rises, as a result of fall in blood pressure the heart rate rises. During phase III the pressure in the chest is released suddenly as a result the major vessels expand accommodating more blood hence blood pressure (BP) further falls and heart rate (HR) remains high. During phase IV the chest pressure equilibrates and the BP and HR return back to normal.[1 2]

Stress is a real or anticipated disruption of homeostasis or a threat to an individual's well-being. The cardiovascular system is one of the main responders to stress, and electrocardiogram (ECG) is one of the non-invasive modalities to check its functioning. [3 4] According to Hosseini SM, the RR and PR intervals, P wave duration & amplitude and the T wave amplitude, showed significant changes in response to VM. The QRS duration and R wave amplitude did not show significant changes. [1]

The two genders can be as opposite as day and night, yet certain similarities prevail. Both male and females respond differently to stressors. [5] Females have a higher parasympathetic tone than males hence there is a closer control of HR. [6]

According to Denq, phases I, III and IV of VM generated similar responses in both the genders. Phase II however, showed some difference. [7] This research focuses on performance of VM and measuring the BP, HR and ECG changes, both during and after the maneuver. Hence, the aim is to check whether the changes induced in ECG, due to a stressful maneuver like Valsalva, are significant or not. Furthermore, to see if there are any gender differences present in the changes induced. Finding out the significantly affected components of ECG, it can aid in pinpointing the part of the heart that can be targeted for particular investigations or therapies. So, this research will help consolidate the already present knowledge base.

Materials and Methods

This cross sectional study was carried out in the Dept. of Physiology, Khyber Medical College, from October 2019 to April 2020. The sampling population constituted of medical students of first and second year MBBS. A total of 70 males and 70 females were selected. Simple random technique was used for sampling. Samples of 21 females were lost so remaining 49 were included in the research. The percentage of missing data is 17.6% which according to Madley-dowd is acceptable.[8] Subjects that took medications effecting cardiovascular system (CVS) function were excluded. Subjects with co morbid i.e.,

cardiorespiratory or major psychiatric disorders, diabetes mellitus (DM), Thyroid and hypertension (HTN) were excluded. Smokers were also excluded from the study.

Witten informed consent was taken from each subject. After which they were asked to perform VM for 15 seconds. They had to blow into a disposable mouthpiece which was connected to an oral manometer, while maintaining 40mmHg pressure. The nose-clip was applied during this procedure. Continuous ECG was recorded in lead II for 15 seconds during the manoeuvre and 1 minute after it. Heart rate and blood pressure were also recorded using Omron M2 Basic automated device, during and after the procedure. The ECG parameters for every second beat were measured and an average was computed for each parameter. This was done for 15 second strip and for the 1-minute strip every fourth beat was taken into account.

The data was analyzed using SPSS version 26.0 for Mac. The during and after values of parameters were assessed using paired sample t test after checking normality of data. The data was then stratified for gender and BMI. BMI was classified using the WHO formula. [9]

Results

A total of 119 subjects were included in the research, out of which 58.8% (70) were male and 41.18% (49) were females.

Table 1: Gender stratification of BMI

BMI categories	Gender	
	Male % (N)	Female % (N)
Underweight	12.9 (9)	18.4(9)
Normal	72.9(51)	69.4(34)
Overweight	14.3 (10)	12.2 (6)
Obese	0(0)	0(0)
Total	100(70)	100 (49)

Table 2: Gender stratification of blood pressure and heart rate findings

Parameters tested during and post stress	Male						Female					
	Mean (SD)	r (for change)	Mean (SD) for change	95% CI	df,t	p	Mean (SD)	r (for change)	Mean (SD) for change	95% CI	df,t	p
DBP during stress	89.78 (13.85)	.522**	7.83 (11.85)	5.0-10.65	69, 5.52**	0.00	84.83 (14.11)	.486**	8.14 (12.56)	4.53 - 11.75	48, 4.53**	0.00
DBP post stress	81.96 (8.24)						76.69 (9.24)					

SBP during stress	139.1 (19.1)	.404**	10.67 (18.46)	6.27 - 15.07	69, 4.83**	0.00	127.53 (18.19)	.557**	17.61 (15.13)	13.26- 21.95	48, 8.14**	0.00
SBP post stress	128.41 (13.7)						109.91 (9.31)					
HR during stress	85.27 (16.64)	.473**	1.52 (15.8)	- 2.24 - 5.29	69, 0.81	0.42	87.73 (15.39)	.628**	4.93 (12.38)	8.4- 1.38	48, 2.79**	0.007
HR post stress	83.74 (13.76)						92.67 (12.79)					

DBP=Diastolic Blood Pressure, SBP= Systolic Blood Pressure, HR= Heart Rate

Diastolic and Systolic pressures as well as heart rate before and after stress application were correlated in both the genders. In males only change in blood pressure was significant ($p<0.01$). While in females change in blood pressure as well as heart rate were significant during and after Valsalva maneuver ($p<0.01$). All cardiovascular parameters were positively correlated with each other. (Table 2)

Table 3: Gender stratification of ECG waves before and after stress

ECG Parameters tested during and after stress	Male						Female					
	Mean (SD)	r (for change)	Mean (SD) for change	95% CI	df, t	p value	Mean (SD)	r (for change)	Mean (SD) for change	95% CI	df, t	p value
RR during stress	0.63 (0.11)	.585**	0.14 (0.11)	0.16- 0.11	69, 10.57**	0.00	0.58 (0.12)	.681**	0.012 (0.09)	0.15- 0.09	48, 8.85**	0.00
RR post stress	0.77 (0.12)						0.71 (0.12)					
PR during stress	0.12 (0.12)	.484**	0.00 (0.01)	0.01- 0.0	69, 5.85**	0.00	0.12 (0.03)	.942**	0.01 (0.01)	0.01- 0.0	48, 5.25**	0.00
PR post stress	0.12 (0.13)						0.13 (0.04)					
QT during stress	0.33 (0.03)	.901**	0.02 (0.01)	0.03- 0.02	69, 12.1**	0.00	0.34 (0.02)	.715**	0.02 (0.02)	0.03- 0.02	48, 9.22**	0.00
QT post stress	0.36 (0.04)						0.37 (0.02)					
P amplitude during stress	0.19 (0.07)	-.171	0.02 (0.16)	0.01- 0.05	69, 1.04	0.3	0.19 (0.04)	-.033	0.02 (0.11)	0.00- 0.05	48, 1.69	0.09
P	0.17						0.16					

amplitude post stress	(0.12)						(0.1)					
P duration during stress	0.08 (0.01)	.056	0.00 (0.01)	0.0-0.0	69, 0.87	0.38	0.08 (0.0)	-.025	0.01 (0.1)	0.04-0.01	48, 1.15	0.25
P duration post stress	0.08 (0.00)						0.09 (0.1)					
T during stress	0.21 (0.1)	.441**	0.05 (.01)	0.07-0.02	69, 4.32**	0.00	0.19 (0.05)	.572**	0.02 (0.05)	0.03-0.0	48, 3.35**	0.002
T post stress	0.26 (0.09)						0.21 (0.05)					
QRS during stress	0.09 (0.01)	.457**	0.00 (0.01)	0.0-0.0	69, 0.93	0.35	0.09 (0.02)	.433**	0.00 (0.01)	0.0-0.0	48, 1.09	0.282
QRS post stress	0.09 (0.01)						0.09 (0.01)					
ST during stress	0.08 (0.01)	.564**	0.00 (0.01)	0.0-0.0	69, 3.21**	0.002	0.09 (0.01)	.444**	0.00 (0.01)	0.0-0.0	48, 0.57	0.569
ST post stress	0.08 (0.01)						0.08 (0.01)					

Both amplitude as well as duration of P wave showed no significant change both during and after Valsalva maneuver in both the genders, neither were they correlated. Similarly, the QRS complexes showed no significant change although their during and post stress application values were positively correlated with each other. The ST duration showed a significant change in males ($p<0.01$), while in females the change wasn't significant, and positive correlation was present in both. The rest of the ECG parameters showed a significant change during and after stress application ($p<0.01$). (Table 3)

Discussion

The results indicate that when a physical stress was applied there was a significant change in blood pressure as well as heart rate in females. In males on the other hand only blood pressure showed a significant change. According to K. Prabhavathi there is a difference in heart's response to exercise induced stress in both the genders. [10] Further more difference exists in both the genders in terms of blood pressure, body mass index, hemoglobin levels and sex hormones. [11] All these factors can account for the gender difference in heart rate significance level, in response to stress, in the present study. In the present study both the genders' RR, PR and QT intervals as well as T wave amplitude showed significant change. The changes in these three intervals here depict the effect of conduction through the heart, hence having an effect on heart rate. The T wave is a representative of repolarization wave moving through the ventricular muscle hence, it is an indirect contributor towards heart rate. [12]

ST segment showed a significant change only amongst males in this study. The rest of the parameters including P wave duration and amplitude and QRS complex showed no significant change. Literature reveals that QRS complex if wide may show a decreased heart rate and if large/ long may show increase muscle mass or ventricular hypertrophy. So, no change is a good sign as QRS complex pathology is one of the most sensitive and serious parameters for disease detection. [13]

P wave represents the depolarization wave spreading from SA node to the atria. Hence, we can calculate the atrial rate by counting and calculating the time interval between consecutive P waves. [14] QRS complexes are formed when ventricles depolarize. So, by counting the time intervals between consecutive QRS complexes we can calculate ventricular rate. [14]

R wave in the QRS complex is one way of determining heart rate, similarly P wave and for that matter, tip of any wave can be used. Hence, in a normal heart, these waves must have a consistent pattern and distance between them. [13]

T wave represents ventricular repolarization. A study showed an increase in amplitude of T wave after physical stress. While during stress, no change or decreased amplitude of T wave was noted. Different parts of myocardium respond differently to stress and the resultant changes in action potential maybe responsible for majority of changes. [15] The same study also inferred that QT duration decreased during exercise and this decrease is proportional to increase in heart rate. [15]

The amplitude and duration of different waves depend upon blood potassium and calcium levels, hematocrit, electrical axis and the movement of the chest wall and diaphragm. The last factor being the most important in the present study. [16] Research shows that RR interval decreases during exercise while P and T wave amplitude increase after exercise. [17]

The limitation of this study is that we can't generalize the findings to all kind of stressors, but only to those conditions which raise the pressure within the chest cavity. Such changes decrease venous return and hence cardiac output. Moreover, the participants were healthy young adults hence, an issue regarding generalization towards older diseased population exists. The strengths include that in this research a comparison of ECG changes during and after the VM is provided. Hence, in a comparative study like this we can detect and even predict the effect of stress on ECG and in turn representative heart areas. Similar stress which is of acute type may be induced on the body in hyperventilation, deep sea diving, defecation, bouts of cough and other conditions which increase pressure inside the chest. Furthermore, taking young healthy adults as a sample helps figure out physiology of stress response, unlike majority of studies which were done in diseased populations.

Conclusions

The parameters of ECG which have a direct relation to the heart rate showed a significant change. While the rest of the ECG waves that usually depict atrial or ventricular excitability/contractility showed no significant changes as a result of stress application. T wave which points out ventricular repolarization also showed a significant change during stress application.

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