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Heart Rate and Blood Pressure Variability to Autonomic Stressors

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Abstract

Background: *Cardiovascular Autonomic Function has not found a quantifiable marker. Recent research has demonstrated a strong correlation between ANS and CV morbidity, including as abrupt death and malignant arrhythmias. The distinguishing feature of such indicators is heart rate variability. These tools have been used by physiologists and clinical cardiology researchers.* ***Methods:*** *A total of n=60 subjects were included in the study they were n=30 cases of hypertension (Group T) and n=30 normotensive subjects acting as controls (Group C). routine CV ANFT tests were performed. The ECG Electrodes were fixed in the Left arm, Right arm and left leg and ground electrode on the right leg. 2) Respiratory belt was tied around the chest at the level of nipple to record respiratory movement. 3) The electrodes and the respiratory belt were connected to Power lap equipment. Blood Pressure cuff was tied to the right upper arm and connected to an automated non-invasive BP monitor.* ***Results:*** *A total of n=60 subjects were included in the study they were n=30 cases of hypertension (Group T) and n=30 normotensive subjects acting as controls (Group C). The age range of the group T was from 30.5 – 45 years and the mean age was 38.5 years for the group C the age ranges was from 28 – 42 years and the mean age was 33.5 years. The values of Deep breathing, vasalva manoeuvre and 30/15 ratio on immediate standing is given in table 3. The values were calculated by recording the maximum RR intervals and minimum RR intervals and the mean values of maximum RR divided by mean values of minimum RR intervals. The p values in all the three conditions were found to be < 0.05 and considered significant.* ***Conclusion:*** *The important observations of the current study were there was a significant reduction of RR ratio in the study group during deep breathing for one minute. Valsalva ratio in the study group was found to be significantly higher than the control group. There was a significant cardiovascular parameter in control group during standard isometric hand grip exercise and also during the cold pressor test. Therefore, a bedside evaluation based solely on blood pressure readings may not accurately reflect the physiology in the notion of normotensive hypertension.*

Keywords*: Heart Rate, Blood Pressure, Variability, Cardiovascular Autonomic Functions*

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Introduction

The most prevalent ailment and the main cause of doctor visits is hypertension. This is now one of the leading causes of death and morbidity in the globe, and as more of the world gets developed, it is anticipated to have a bigger influence on public health. [1] In addition to these occurrences, undiagnosed normotensive hypertension is a significant risk factor that raises an individual's (or the population's) likelihood of developing a wide range of cardiovascular (CV) disorders. [2] More and more patients will qualify for antihypertensive medication during the coming years. A persistent increase in both systolic and diastolic blood pressure is referred to as hypertension. [3] Idiopathic and polygenic in nature, environmental variables have a significant role in the development of essential hypertension. Other than a small number of cases where blood pressure control and related dysfunctions have a single hereditary foundation, essential hypertension results through interactions between a variety of environmental and genetic variables. [4] We can also see that a variety of systems, such as the cardiovascular, vascular, renal, endocrine, nervous, etc., may be involved in the development and maintenance of hypertension. It is important to keep in mind that even if the person is listed as hypertensive, adjustments have already been made to the CVS and other systems. As a result, normotensive hypertension must be detected (or predicted) as early as feasible. [2] Even a mild increase in arterial pressure shortens life expectancy. There is a considerable association between inherited variables and essential hypertension in the majority of patients, as has conclusively shown (rats). [5] Changes in the heart and blood vessels may be regarded risk factors for cardiovascular disease rather than indicators of an existing illness. These cardiovascular risk factors include alterations in lipid metabolism, obesity, insulin resistance, arterial stiffness, left ventricular hypertrophy, renal illness, and abnormalities in the autonomic nervous system's function. [6] The ANS-related alterations are crucial in adjusting the heart and circulation to operate within physiological limits.

It was formerly considered that the baroreflex had little to do with long-term blood pressure management, but there is currently a lot of strong discussion over the baroreflex mechanism's significance in long-term BP control. [7] Recent research suggests that arterial baroreflex mechanisms do indeed function at a somewhat greater level in normotensive hypertensive patients. Baseline autonomic levels in HT and whether normotensive HT differ in terms of blood pressure and HR responses to a simple autonomic reflex test are the two arms of the control of cardiovascular autonomic function. The BP will rise in response to an increase in cardiac output (CO), HR, or both. A disruption of the autoregulation of tissue blood flow called essential hypertension. Reduced vagal discharge from the central nervous system (CNS), increased sympathetic drive to the heart and blood vessels, or an increase in preload in renal illness might all be contributing factors to this imbalance. [8] With the use of a common autonomic function test, the current study aims to assess the cardiovascular autonomic response in normotensive as well as hypertensive subjects. This comprises the BP and HR changes during the prolonged isometric hand grip test (SIHG), the BP and HR changes while quiet standing, the HRV during deep breathing, the Valsalva ratio during the Valsalva maneuver, and the cold pressor test (CPT).

Materials and Methods

A total of n=60 subjects were included in the study they were n=30 cases of hypertension (Group T) and n=30 normotensive subjects acting as controls (Group C). After emptying their bladders, the individuals were required to sit in the lab for 10 minutes to become used to the new surroundings. One and half hours before to the test, the individuals were expressly told not to consume any coffee, tea, or cold beverages. Their height in metres and weight in kg were assessed during a clinical examination to rule out any acute or chronic disease as well as any autonomic dysfunction. The CV ANFT process was then taught to the subjects. Following that, the following routine CV ANFT tests were performed. The ECG Electrodes were fixed in the Left arm, Right arm and left leg and ground electrode on the right leg. 2) Respiratory belt was tied around the chest at the level of nipple to record respiratory movement. 3) The electrodes and the respiratory belt were connected to Power lap equipment. Blood Pressure cuff was tied to the right upper arm and connected to an automated non-invasive BP monitor.

Base line BP, HR & HRV

ECG was recorded for 5 mins to determine the HRV at supine rest with the eyes closed with normal quite respiratory movement (12-16/min). Base line BP was recorded at the end of 5 mins at supine position.

BP, HR & HRV response to standing

After recording in the supine position the subjects were asked to stand without support on a wooden plank within 3 seconds and his BP and HR were recorded at the end of 5 sec, 2 mins and 5 mins after assumption of standing position.

HRV During Deep Breathing

After recording the standing position, the subject was asked to lie down comfortably in the supine position. He was then instructed to breath slowly and deeply at a rate of 6 breath per minute in such a way that he takes 5 seconds for each inspiration followed 5 seconds for expiration. The entire procedure was monitored on the screen

Heart Rate Changes During Valsalva Maneuver

The subject was made to sit comfortably on a chair. They are instructed to blow the air through the tube of the mercury manometer to keep the mercury pressure at 40mm and sustained at 40 mmHg for 15 sec. repeated this test 3 times with time interval of 3 minutes each. Valsalva ratio (VR) was obtained between the maximum RR and the minimum RR for each event and the maximum ratio was taken as the VR value. BP and HR changes during Sustained Isometric Handgrip Test (SIHG) Using hand dynamometer, the subjects are asked to produce 30% of maximum voluntary contraction on the non-dominant hand at least for 60 sec. BP was recorded on the other hand at the end of 1 minute of sustained handgrip.

BP and HR Changes During Cold Pressor Test (CPT)

The subject was seated comfortably, and his left hand was immersed upto the wrist in the cold water 8 ± 2 degrees Celsius for 1 minute. At the end of 1-minute BP was recorded on the other hand. Although the recommendation for CPT is 4°C but our climatic condition allowed us to do at 8°C for 1 minute.

Data collection and analysis were carried out using an MS Excel spreadsheet and SPSS version 22. (Chicago, IL, USA). While qualitative factors were stated in proportions and percentages, quantitative data were expressed using means and standard deviations. In order to determine the difference between two proportions, Fisher's exact test was performed.

Results

A total of n=60 subjects were included in the study they were n=30 cases of hypertension (Group T) and n=30 normotensive subjects acting as controls (Group C). The age range of the group T was from 30.5 – 45 years and the mean age was 38.5 years for the group C the age ranges was from 28 – 42 years and the mean age was 33.5 years. The p values were 0.125 and considered not significant.

Table 1: Anthropometric analysis

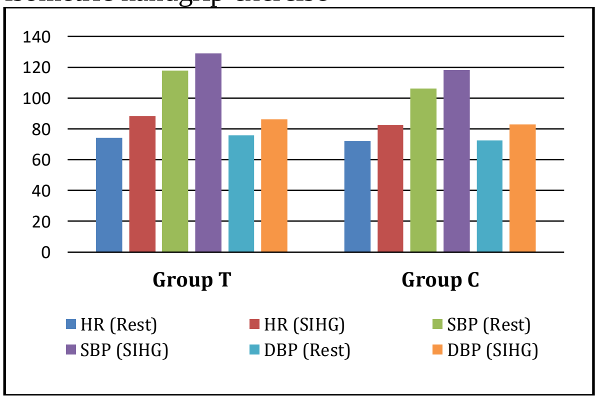
Variable	*Groups*	*Range*	*Mean*	*P value*
Age in years	Group T	30.5 – 45.0	38.5	0.125
	Group C	28.0 – 42.0	33.5	
Height in cms	Group T	158.5 - 174.5	167.8	0.154
	Group C	159.4 – 172.6	166.5	
Weight in Kg	Group T	61.5 - 73.5	64.5	0.139
	Group C	59.5 - 68.5	70.0	
BMI	Group T	23.5 – 30.1	25.8	0.243
	Group C	22.5 – 27.5	24.1	

Table 2: Variables in the cases

Variable	*Groups*	Mean at rest	*Mean at 2 minutes of standing*	*P value*
SBP mmHg	Group T	124.0 ± 12.0	130.0 ± 13.0	0.04*
	Group C	112.0 ± 8.0	118.0 ± 10.0	
DBP mmHg	Group T	82.0 ± 6.0	90.0 ± 6.0	0.06
	Group C	72.0 ± 4.0	84.0 ± 5.0	
HR bpm	Group T	74.0 ± 6.0	80.0 ± 5.0	0.02*
	Group C	78.0 ± 8.0	86.0 ± 6.0	
RPP	Group T	7080 ± 1090	8190.0 ± 1240	0.01*
	Group C	8840 ± 1120	9560.0 ± 1430	

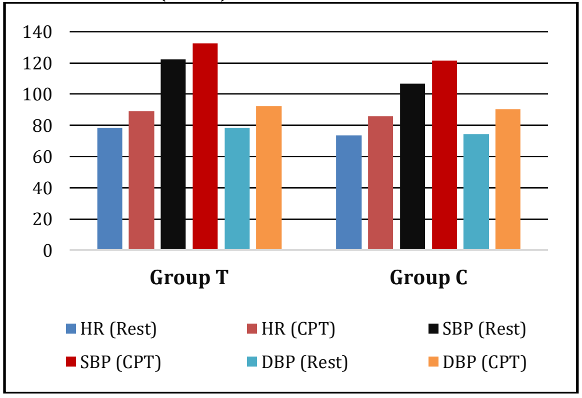
* Significant

Figure 1: Parameters at rest & during sustained isometric handgrip exercise



The rate pressure product was calculated in both the groups during rest and sustained isometric handgrip exercise in the control group the mean RPP at rest was 7010 and after SIHG was 8838 similarly, the RPP in the group T at rest was 8200 and after SIHG was 9880. The other values of the parameters recorded during the SIHG have been depicted in Figure 1.

Figure 2: Parameters at rest and during Cold Pressor Test (CPT)



The rate pressure product was calculated in both the groups during rest and cold Pressor Test in the control group the mean RPP at rest was 7010 and after CPT was 9820 similarly, the RPP in the group T at rest was 8264 and after CPT was 10504. The other values of the parameters recorded during the CPT have been depicted in Figure 2.

Table 3: Ratio of Deep breathing, Vasalva maneuver & 30/15 ratio on immediate standing

	Group	*Mean ± SD*	*P values*
DB max/min RR interval	Group T	1.121 ± 0.12	0.041*
	Group C	1.350 ± 0.15	
VR max/min RR interval	Group T	1.252 ± 0.14	0.012*
	Group C	1.330 ± 0.10	
30/15 Sec Standing RR Interval	Group T	1.190 ± 0.17	0.011*
	Group C	1.323 ± 0.21	

* Significant

The values of Deep breathing, vasalva maneuver and 30/15 ratio on immediate standing is given in table 3. The values were calculated by recording the maximum RR intervals and minimum RR intervals and the mean values of maximum RR divided by mean values of minimum RR intervals. The p values in all the three conditions were found to be < 0.05 and considered significant.

Discussion

The balance between Parasympathetic Nervous System and Sympathetic Nervous System output and the autonomic nervous system are crucial for maintaining overall cardiovascular homeostasis. It is consistent with the prevalence of a hyperdynamic circulatory condition during maneuvers like orthostatic load, isometric hand grip, CPT, etc. that HRV responses are much lower in the study group. [9] As determined by SDNN Index, there was no convincing proof that there was a substantial difference in the average heart rate variability. However, there was a considerable rise in the test group's resting heart rate. When compared to the control group, the LF in nu in the study group was higher. [10] Even while SDNN, the square root of variation, is a trustworthy indicator of overall HRV, it offers no insight into how quickly the heart rate response could be mediated. The considerably greater LF/HF ratio in the study group, even in the supine position, was another noteworthy and intriguing difference between the control and study groups. [10] This is because the research group's HR has a higher LF modulation and a lower HF modulation. Therefore, it was clear that sympathetic overactivity was the most likely cause of the LF modulation. This in turn happens as a result of oscillations in the sympathetic drive to the blood arteries that have central origins. This suggests that some members of the population could develop overt hypertension at a young age. [11] As the LF component, a measure of sympathetic activity, is very low during supine position and the majority of HRV in supine position is due to vagal modulation, which could be abolished by atropine, the LF/HF ratio in the supine position during normal quit breathing at 12 to 16/min is not a good indicator for sympatho-vagal interplay. However, the ratio becomes crucial while standing because in the research group where the LF/HF ratio has greatly risen, there is either a vagal withdrawal or an increase in sympathetic activity. Standing significantly increased the HR, BP, and RPP in both the study and control groups. The study group had a considerably lower percentage rise in HR, BP, SBP, and RPP after only standing up. Despite the fact that both groups' percentage changes in HR, BP, and RPP after 2 minutes and 5 minutes of standing showed an increase. It had little statistical significance. The complex autonomic responses induced by standing to counteract the effects of gravity on circulation rely primarily on the actions of local venoarteriolar axon reflexes and functionally specialized stretch receptors (baroreceptors), which activate baroreflexes. [12]

Additional mechanisms that contribute to the response to standing peripheral vascular resistance increase through sympathetic vasoconstriction and heart rate increases due to both vagal withdrawal and sympathetic activation include the exercise reflex. [13] Capillary fluid shift systems, effects of endothelial and neurohormonal factors that modulate baroreflexes or act directly on blood vessels, the heart, and the kidneys. The overall result is an increase in heart rate and blood pressure to keep them at levels that are similar to those while supine (although the pulse pressure may be decreased). [14] Measurements of heart rate and blood pressure taken while standing give crucial information about the health of the reflex mechanisms that are activated to counteract the effects of gravity. The HR and arterial blood pressure rise while an isometric hand grasp is maintained against opposition. The cardiovascular response is mediated by tiny fibers in the afferent limb of the reflex arc, which are activated by metabolic or mechanical changes in contracting muscle, or both. The exercise response, which pulls down parasympathetic activity and promotes sympathetic activity, is what produces sustained muscular contraction, which raises blood pressure and heart rate.

A rise in blood pressure and cardiac output are often brought on by reflex arterial vasoconstriction caused by cutaneous pain receptors when a hand is submerged in cold water. Increased sympathetic activity causes vascular resistance to rise, which in turn raises blood pressure. Adrenoreceptor blockers reduce the first rise in heart rate, indicating that sympathetic rather than parasympathetic outflow causes this response. The cold pressor test has been used to measure efferent sympathetic outflow, but the response involves a reflex arc that also includes afferent sensory nerves (pain), spinothalamic tracts, suprapontine, and intrathalamic relays, in addition to efferent sympathetic pathways and peripheral sympathetic receptors. [15] Our data supports past studies that found a drop in RPP in the study group, presumably as a result of decreasing HRV immediately following the maneuver. The activation of the carotid sinus, aortic arch, and other intrathoracic stretch receptors during the valsalva maneuver causes alterations in the cardiac vagal efferent and sympathetic vasomotor activity. The parasympathetic and sympathetic functions are both measured by the valsalva ratio. The valsalva ratio (VR) in this study was 1.252 ± 0.14 for the control group and 1.330 ± 0.10 for the experimental group. The study group has experienced a statistically significant decline. A VR of 1.2 or above is considered to be typical. Combinations of the elements may have the tendency to lessen provoked tachycardia and vasoconstriction as well as decrease left ventricular output under the strain of the valsalva maneuver. Declining VR in the research group, then is the early physiological adaptation of chromic volume overloads state.

Conclusion

The important observations of the current study were there was a significant reduction of RR ratio in the study group during deep breathing for one minute. Valsalva ratio in the study group was found to be significantly higher than the control group. There were a significant cardiovascular parameters in control group during standard isometric hand grip exercise and also during the cold pressor test. Therefore, a bedside evaluation based solely on blood pressure readings may not accurately reflect the physiology in the notion of normotensive hypertension. However, the autonomic function test and HRV analysis may potentially provide additional information for comprehending blood pressure management.

***Conflict of Interest*: None**
***Source of support*: Nil**
***Ethical Clearance*: Obtained**

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