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Study of Autonomic Function Tests in Hypertensives

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Abstract: **To study the variations of autonomic nervous system in hypertensive patients using a set of autonomic function tests. The study included 50 hypertensive patients and set of autonomic function tests were done to assess the autonomic functions. These results were compared with age and sex matched controls (normotensives). The subjects were selected based on exclusion-inclusion criteria. Hypertensives show abnormal values on autonomic function testing, when compared with normotensives. The statistically significant differences were found between hypertensives and normotensives in some autonomic function tests. The results were obtained using ANOVA and student't' –test, to study the significance of autonomic parameters. Results showed that there was significant increase in the Heart rate response to standing. Valsalva ratio & Heart rate response to deep breathing test values were decreased in Hypertensives as compared to Normotensives ($p<0.05$). S: L ratio also decreased, and the decrease was statistically significant ($p<0.05$). Isometric handgrip exercise and cold pressor tests shows that there was significant rise in the systolic and diastolic blood pressure in Hypertensives as compared to Normotensives increase was statistically significant ($p<0.05$). From this study, it is evident that Hypertension can alter the normal autonomic functions of the body and predisposes to autonomic neuropathy. Early and regular screening of these individuals is necessary to prevent any future complications.**

Keywords: **Autonomic nervous system, Hypertension, Blood Pressure, Valsalva ratio, Deep Breathing Test, Cold pressor test.**

I. INTRODUCTION

The autonomic nervous system plays a crucial role in blood pressure (BP) and heart rate (HR) control and may thus be an important pathophysiological factor in the development of hypertension. Hypertension is one of the common non-communicable disease which is usually asymptomatic but readily detectable and treatable condition and often leads to lethal complications like coronary heart disease, stroke etc. if left untreated. It is probably the most important public health problem in all developed countries as they have achieved a successful control of much infectious and communicable disease.

Hypertension is defined as a sustained elevation of systemic arterial blood pressure. It is commonly due to increased peripheral resistance or increased cardiac output, but most commonly due to increased peripheral resistance. It can be produced secondary to many diseases or more commonly without any cause. Hypertension is the term used to describe high blood pressure.

The major complications of hypertension are: Excess work load on the heart leads to heart failure and coronary heart disease, often leads to death due to heart attack, High pressure damages a major blood vessels in brain, it is a cerebral infarct clinically it is called stroke. A stroke can cause Paralysis, dementia and blindness; High pressure almost causes injury in kidneys leads to renal failure, uraemia and death.

The Autonomic Nervous System regulates the 'automatic' functions of the body such as blood pressure, heart rate, breathing, stomach and intestinal function, and bladder function. If it becomes unbalanced, a person may experience a variety of symptoms. Disorders of the autonomic nervous system can be identified through autonomic function testing.

For these tests a person will be attached to a blood pressure machine which monitors the blood pressure continuously and an electrocardiograph which monitors the heart rhythm continuously. The present study was conducted to identify the changes in autonomic functions in hypertensive patients by evaluating the autonomic function tests.

II. MATERIALS AND METHODS

Methodology:

This study was undertaken by me on behalf of Department of Physiology, Narayana Medical College. The approval of Department of Cardiology and Medical ethics committee of Narayana Medical College, Nellore was taken for this "Study of Autonomic function tests in Hypertensives". Subjects were selected from Narayana General Hospital attending Cardiology outpatient department for master health check up, aged between 25 to 65 years, who volunteered to take part in the study. The procedure was explained and written consent was obtained from the subjects. All the subjects underwent a detailed clinical examination before being included in the study as per the study protocol. The subject selection was based on the predetermines exclusion-inclusion criteria.

Inclusion criteria:

***Study group*:**

Controlled Hypertension for more than 2 years

Males and females aged 25-65 years

Normal body mass index (BMI: 19-25 Kg/m^2)

Normal Cardiovascular and Respiratory system on clinical examination

No history of Diabetes mellitus

No history of any acute infectious diseases

No history of any chronic diseases

***Control group*:**

Normotensive population

Males and females aged 25-65 years

Normal body mass index (BMI: 19-25 Kg/m^2)

Normal Cardiovascular and Respiratory system on clinical examination

No history of Diabetes mellitus

No history of any acute infectious diseases

No history of any chronic diseases

Exclusion Criteria:

< 25 years and > 75 years of age

History of Diabetes mellitus

History of Connective tissue disorders

History of Congenital heart diseases

History of Coronary artery disease

History of pericardial disease

History of valvular heart disease

History of cardiac arrhythmias

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Patients where it was technically difficult to perform echocardiography

Abnormal Cardiovascular and Respiratory system on clinical examination

The autonomic function tests studied were:

I. Deep breathing test - This test is used to assess the parasympathetic activity. Subject was instructed to maintain deep breathing at a rate of six breaths per minute and was made to lie down comfortably in supine position with head elevated to 30^0. ECG electrodes were connected for recording Lead II ECG. While subject was breathing deeply at a rate of 6 breaths per minute (allowing 5 seconds each for inspiration and expiration) maximum and minimum heart rates were recorded with each respiratory cycle. Expiration to inspiration ratio was determined by using the formula.

II. Valsalva Manoeuver - The valsalva ratio is a measure of parasympathetic and sympathetic functions. Subject was made to lie down in a semi recumbent or sitting position. Nostrils were closed manually. Mouth piece was put into the mouth of the subject and the Mercury manometer was connected to the mouth piece. ECG machine was switched on for continuous recording. Subject was asked to exhale forcefully into the mercury manometer and asked to maintain the expiratory pressure at 40 mm of Hg for 10 – 15 seconds. ECG changes were recorded throughout the procedure, 30 seconds before and after the procedure.Valsalva ratio were calculated by using the formula.

III. Cold Pressor test (cold pressure test): Subject was instructed regarding the test. Blood pressure was recorded under basal conditions. Cold water was taken in a container. Subject was asked to submerge one of his upper limbs in cold water for 60 seconds. Blood pressure was recorded at the end of 60 seconds of submersion of the limb. Submersion of the limb in ice cold water increases systolic blood pressure by about 10-20 mm of Hg and diastolic blood pressure by about 10 mm of Hg.

IV. Heart rate response to standing: On changing the posture from supine to standing heart rate increases immediately by 10-20 beats per minute. This response is detected by recording ECG in supine and standing postures. Subject was made to lie down in supine posture. ECG electrodes were connected from the subject to the cardiowin system. Subject was asked to relax completely for a minimum period of 10 minutes. Basal heart rate was recorded by using cardiowin system. Subject was asked to stand up immediately and change in heart rate is noted from the monitoring screen of cardiowin. Heart rate response to standing was determined by using the formula heart rate in standing position – heart rate in supine position.

V. Hand Grip Test: In the hand grip test, there is a rise in heart rate and blood pressure. The blood pressure rise is due to increased sympathetic activity and heart rate rise is due to decreased parasympathetic activity. Subject was made to lie down in semi recumbent position. ECG electrodes were connected for lead II recording of ECG and sphygmomanometer for blood pressure measurement. Basal heart rate and blood pressure were recorded. Subject was asked to maintain a pressure of 30% of the maximum activity in the hand grip dynamometer for about 5 minutes. Heart rate and change in SBP, DBP were recorded.

VI. The S: L (standing to lying) ratio was taken as the ratio of the longest R-R interval during the 5 beats before lying down to the shortest R-R interval during the 10 beats in the ECG after lying down.

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III. RESULTS

Results were analyzed by ANOVA with SPSS version 17.0 using an unpaired't' test.

Table.1: Anthropometric variables

Variables	Hypertensives	Normotensives
Age(yrs)	39.50±5.4	39.47±4.8
Weight(kgs)	76.13±4.9	68.11±4.3
Blood Pressure(mm of Hg)	SBP-159.83±10.2 DBP-100.23±5.2	SBP-124.63±10.2 DBP-78.43±5.2

Table.2: Parasympathetic function tests in Group I and Group II

Variables	Hypertensives	Normotensives	P value
Heart rate response to standing	19.667	13.667	<0.05
S:L (standing to lying)ratio	1.11±0.02	1.2±0.03	<0.05
Valsalva ratio	1.45±0.11	1.65±0.28	<0.05
Heart rate response to deep breathing(HRDB)	16.46±2.11	23.46±4.31	<0.05

Table.3: Statistical analysis of sympathetic function tests in Group I and Group II

Variables	Hypertensives	Normotensives	P value
Isometric Handgrip SBP	12.2±1.2	8.3±1.3	<0.05
Isometric Handgrip DBP	12.1±1.4	8.1±1.2	<0.05
Cold Pressor Test SBP	12.2±1.6	8.2±1.4	<0.05
Cold Pressor Test DBP	13.1±1.8	9.1±1.4	<0.05

Data presented in Table 2 shows that there was significant increase in the Heart rate response to standing. Valsalva ratio & Heart rate response to deep breathing (HRDB) was decreased in Hypertensives as compared to Normotensives ($p<0.05$). S: L ratio also decreased, and the decrease was statistically significant ($p<0.05$).

Data presented in Table 4 shows that there was significant rise in the systolic and diastolic blood pressure in Hypertensives as compared to Normotensives during the application of isometric handgrip exercise and cold pressor tests ($p<0.05$) and the increase was statistically significant ($p<0.05$).

IV. DISCUSSION

The results of the present study showed that the valsalva ratio and heart rate response to deep breathing in hypertensives were significantly lower as compared to the control group, it indicates base line levels of vagal cardiac nerve activity and vagally mediated arterial baroreceptor cardiac reflex responses are decreased in hypertensive subjects. This decreased parasympathetic activity leads to decreased heart rate variability with respiration, which is reflected in our study as decreased E: I and Valsalva ratio values in Hypertensives. The findings in our study correlated with the study conducted by Knut severe et al. The results for the above mentioned tests are statistically significant.

When a subject assumes an erect posture from supine posture, gravity causes pooling of blood in the lower limbs. As a result venous return, cardiac output and arterial BP decreases. This leads to decrease stretch of baroreceptors and activation of vasomotor centre. This in turn leads to increased sympathetic discharge, decreased vagal tone and an instantaneous increase in HR. In our study, Heart rate response to standing values were increased in all the subjects but this heart rate was significantly increased in hypertensive group when compared to the normotensive group. This finding indicates possible dysfunction of sympathetic and parasympathetic component of autonomic nervous system. The findings in our study correlated with the study conducted by WW McCrory, AA Klein et.al.

There was an increase of blood pressure response to cold pressor test in the hypertensives in contrast to the control group. The afferent fibers for this response are the pain fibers which are stimulated by placing the hand in cold water and the efferent fibers are the sympathetic fibers. An increase in the blood pressure after the cold water immersion points towards sympathetic hyperactivity in hypertensives. Hypertension impairs autonomic control of heart rate and blood pressure. In our study there is significant rise in both systolic blood pressure and diastolic blood pressure in hypertensive group. The pattern of rise of blood pressure was within 30 seconds reaching its peak at around 60 seconds and the basal blood pressure was achieved within 2 minutes in normotensive subjects and prolonged pressor response was found in hypertensive patients. Generally, Cold pressor test is largely related to great sympathetic efferent discharge causing arterial vasoconstriction. Hypertensive subjects respond to cold pressor stimulus with a predominant rise in total peripheral resistance and also there were higher levels of plasma norepinephrine. The findings in our study correlated with the study conducted by Benetos A. and Douglas L. et.al.

Isometric exercise produces a significant increase in blood pressure and heart rate, a response which can easily be elicited by using sustained hand grip. In hand grip test, increase in blood pressure is due to increased sympathetic activity mediated by the alpha adrenergic receptors of the autonomic nervous system. An increase in heart rate in response to handgrip is due to impulses from the Limbic cortex, motor cortex and the proprioceptors within small hand joints acting as afferent inputs into the medullary cardiac centres causing inhibition of cardiac inhibitory centre, decrease in vagal tone and increase in heart rate. The results of the present investigation have demonstrated that sustained handgrip causes significant increase in arterial pressure in hypertensive patients. The findings in our study correlated with the study conducted by S.G. Chrysant et.al[10].

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Conflict of Interest: Nil

V. CONCLUSION

Hypertension is associated with both sympathetic and parasympathetic nervous system dysfunction which may result in various cardiovascular complications. So, if this dysfunction is diagnosed early by doing various autonomic function tests, it will be of great help in identification of those which are prone to risk of various cardiovascular complications.

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