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Evaluation of autonomic activity in individuals with family history of hypertension

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ABSTRACT

Introduction: The global prevalence of hypertension has increased to more than 25% of the world population, which is predicted to be increased to 65% by 2025. several studies have found that pediatric hypertensives have decreased heart rate variability (HRV) and higher sympathetic modulation/activation. Evidence suggests that this population may be predisposed to hypertension despite having high arterial blood pressure due to the likelihood of a genetic syndrome of abnormalities. This indicates that the development of hypertension in the children of hypertensives may be significantly influenced by cardiac autonomic dysfunction.

Aims and Objectives: To evaluate the cardiac autonomic modulation in normotensive individuals of hypertensive parents compared to controls.

Materials and Methods: This prospective study was conducted on 100 individuals, out of which 50 of them had a family history of hypertension and another 50 individuals without any family history of hypertension. Anthropometric measurements were taken along with weight, arterial blood pressure, and nerve conduction.

Results: The study has found both systolic and diastolic pressure to be significant in the cold pressor test ($p<0.05$). It has also been shown that there is a significant difference between the two groups ($p<0.05$) in both the systolic and diastolic blood pressure, before and after Isometric Handgrip Test (IHGT). The study has found that heart rate variability is significantly different between the study and control group for each index ($p<0.05$).

Conclusion: The study has found that the systolic and diastolic pressure is significantly higher in individuals with a family history of hypertension after performing the cold pressor test, isometric handgrip test and nerve conduction test ($p<0.05$). The study has shown that autonomic reactivity can be utilized to determine potential hypertension as a screening method for preventive diagnostics of hypertension.

Keywords: hypertension, normotensive, autonomic reactivity, cold pressor test, isometric handgrip test, nerve conduction test

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Introduction

One of the main risk factors for the emergence of cardiovascular disease is hypertension. Currently, 27% of people worldwide have hypertension, and it is predicted that by 2025, this number would have increased by 65%, reaching a frequency of 43%. An important, unchangeable risk factor for the development of hypertension is family history. It is now widely accepted that one of the factors affecting arterial blood pressure is the autonomic nervous system (sympathetic and parasympathetic). Several studies have found that pediatric hypertensives have decreased heart rate variability (HRV) and higher sympathetic modulation/activation. Evidence suggests that this population may be predisposed to hypertension despite having high arterial blood pressure due to the likelihood of a genetic syndrome of abnormalities. This indicates that the development of hypertension in the children of hypertensives may be significantly influenced by cardiac autonomic dysfunction [1-3].

One of the most accepted and well-tested concepts in cardiovascular research is that hypertension results from a dysregulation of parasympathetic and sympathetic cardiovascular control. Its recommendation came as a result of the finding that the cardiovascular system is homeostatically controlled by autonomic cardiovascular effects. Norepinephrine and epinephrine levels in circulating plasma are abnormally elevated in normotensive people with a familial history of hypertension, according to numerous studies. Additionally, similar anomalies can be seen when measurements are taken during actions that stimulate autonomic cardiovascular regulation. Studies show that autonomic abnormalities, including enhanced sympathetic modulation, decreased heart rate variability, and decreased baroreflex sensitivity, are among the modifications that may be responsible for the development of hypertension in normotensive offspring of hypertensive adults. The advent of hypertension in this community has also been linked to vascular anomalies as potential candidates. Similar to people with a family history of systemic arterial hypertension, autonomic and vascular systems disturbances have also been identified as the primary etiological reasons for BP increase in prehypertensive patients [4-7].

Because of its critical function in controlling heart rate and blood pressure, the autonomic nervous system may play a significant pathophysiological role in the emergence of hypertension. Numerous research has been conducted on plasma catecholamine levels in essential hypertension, the majority of which have found elevated levels in hypertensive individuals. Furthermore, baroreceptor reflex sensitivity (BRS) and HR variability (HRV) have been used in various investigations to show that autonomic HR and BP control are impaired. In general, hypertension individuals have lower HRV, which measures tonic HR control. In hypertensive patients, BRS, which calculates the reflexive vagal HR regulation, is decreased. With ageing, both HRV and BRS parameters in hypertensive and healthy people diminish. Additionally, it is suggested that BRS stabilizes with age [8].

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Materials and Methods

Research Design

This is a prospective study which was conducted from August 2021 to September 2022, on 100 individuals. This analysis was executed in the Department of Physiology. It was conducted on 100 individuals, of which 50 individuals had a family history of hypertension and the other 50 individuals are age-matched individuals with no family history of hypertension. Furthermore, this process has suggested the need to refrain from any beverages (tea, coffee, alcohol) for at least 12 hours before joining this study. Alongside, this process time needs to sleep at night as well as need to refrain from any drugs or medicines. Therefore, this procedure should be described before the time of the test without any stress. Before joining this study their height was calculated in centimeters and weight in kilograms and total body index was also measured. In addition, they were told to rest for a minimum of fifteen minutes in the supine role.

Inclusion and Exclusion Criteria

This study has determined normal children of hypertensive parents (n=50). Inclusion criteria have included males, aged (18 to 30 years), non-smokers, hypertensive and more. Similarly, exclusion criteria have comprised BMI>30, non-diabetic, family history of addiction to alcohol and drugs, choric disorders, athletes and others.

Interventions

The standing height was measured by standing against a wall on which a measuring scale was signed. It was determined that standing empty feet on a muted floor against the wall with the feet parallel and heels, buttocks and occiput connecting the wall. The weight was calculated by the digital weighing machine scale and its least count was 0.1 kg. It can be ensured that body weight would be divided between both feet over the middle of the scale. Similarly, it has determined to stand yet, keep her head up and face forward with her hands depending freely by the sides of the body, with palms facing the things. Weight was calculated in lightweight garments without footwear. Resting pulse rate was also determined. This study recorded blood pressure by Arterial blood pressure in the right hand in a sitting position. In addition, digital blood pressure measuring equipment estimated the blood pressure as well as recorded the body temperature. For nerve conduction study, electrodes were placed into Abductor Pollicis Brevis and put on the engine pinpoints viz centre between the proximal wrist fold and the primary metacarpophalangeal joint. The reference electrode is put at 3 cm distance from the recording electrode at the rather metacarpophalangeal joint. The stimulating electrode is placed at 3 cm distal to distal hand crease near the muscle of the Palmaris longus. The proximal stimulation point is considered as the upper arm near the backbone crease of the Brachial Artery pulse.

Ethical Approval

The study obtained requirement consent from the patients after clearly explaining to them the study process. The Ethical Committee of the institute has approved the study

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process.

Statistical analysis

The study used SPSS 25 and excel software for effective statistical analysis. The descriptive measurements were expressed as mean±standard deviation. The study used ANOVA for statistical analysis of baseline characteristics. The mean and common differences were analyzed by using an unpaired *t*-test. The level of significance was considered to be α=0.05.

Results

The study found the baseline characteristics of the study group and control group. The study further found their significance. Table 1 shows the detailed findings of baseline characteristics.

Table 1: The baseline characteristics of the patients in each group

Parameters	Study group	Control group	*p*-value
Age (years, mean±SD)	21.45±2.35	22.11±2.58	0.425
Height (meters, mean±SD)	1.58 ± 0.05	1.57 ± 0.04	0.09
Weight (kg, mean±SD)	53.95±4.55	56.55 ± 4.58	0.15
Body Mass Index (kg/m^2)	22.12±1.85	21.89±1.78	0.13
Systolic Blood Pressure (mmHg)	112.96±6.78	110.56±7.69	0.18
Diastolic Blood Pressure (mmHg)	75.24±9.82	74.24±6.08	0.58
Heart Rate	83.98±11.63	80.3±11.72	0.14

The study employed a cold pressor test, isometric handgrip test, and difference in heart rate during deep breathing test and found both systolic and diastolic pressure to be significant in the cold pressor test ($p<0.05$). Again, the study has shown that there is a significant difference between the two groups ($p<0.05$) in both the systolic and diastolic blood pressure, before and after Isometric Handgrip Test (IHGT). The study also found that the mean difference in heart rate between the two groups, is significant ($p<0.05$). Table 2 shows the findings of the cold pressor test, isometric handgrip test and mean difference in heart rate during the deep breathing test.

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Table 2: Blood Pressure measurements in each group before and after the Cold Pressor Test, Isometric Handgrip Test (IHGT) and the difference in Heart Rate in the Deep Breathing Test

Cold Pressor Test				
		Study group	**Control group**	***p*-value**
Systolic Blood Pressure	Before	117.79±6.93	109.48±7.89	0.13
	After	123.22±7.74	120.48±8.72	0.042
Diastolic Blood Pressure	Before	73.84±5.46	74.04±4.64	0.859
	After	86.04±5.74	84.06±5.52	0.041
Isometric Handgrip Test (IHGT)				
		Study group	**Control group**	***p*-value**
IHGT (SBP)	Before	117.79±6.93	109.48±7.89	0.13
	After	125.22±7.74	120.48±8.72	0.048
IHGT (DBP)	Before	73.84±5.46	74.04±4.64	0.859
	After	85.98±5.74	84.06±5.52	0.049
Mean difference in heart rate during a deep Breathing test				
		Study group	**Control group**	***p*-value**
	Deep Breathing Difference in Heart Rate	13.24±3.87	20.50±7.61	0.038

The study has found that heart rate variability is significantly different between the study and control group for each index ($p<0.05$). However, nerve conduction velocity did not show any significant difference between the study and control group ($p>0.05$). The detailed findings of the nerve conduction test and Heart Rate Variability have been shown in Table 3.

Table 3: Domain indices of Heart Rate Variability (HRV) and nerve conduction velocity between the two groups

Mean frequency domain indices of Heart Rate Variability (HRV)			
Frequency Domain Indices	**Study**	**Control**	***p*-value**
LF (ms^2)	133.42 ± 76.79	98.46 ±55.33	<0.05
HF (ms^2)	117.32±70.14	159.72±106.08	<0.05
LF(n.u.)	69.92 ±9.73	65.64 ±10.92	<0.05
HF(n.u.)	27.78 ± 8.19	32.11±9.57	<0.05
LF/HF ratio	2.86 ±0.98	2.22 ±0.74	<0.05
Nerve Conduction Velocity (Median Nerve)			
Motor	63.51±3.60	59.01±4.10	0.23
Sensory	58.60±3.93	57.87±3.47	0.32

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LF – Low frequency; HF – High frequency; LF (n.u.) – Low frequency normalised unit; HF (n.u.) – high frequency normalised unit.

Discussion

There are many negative repercussions of sympathetic overdrive that result in hypertension, including cardiovascular, metabolic, and renal damage. The development of serious complications of hypertension, such as arrhythmia, left ventricular hypertrophy, and increased arterial stiffening, is thought to be facilitated by a state of sympathetic activation, which is associated with an increased heart rate and may promote cardiac and vascular alterations. The SNS appears to have an impact on hemostasis as well, with acute SNS activation leading to hypercoagulability because of increased platelet aggregability. The onset and progression of heart failure and hypertension are both caused by increased sympathetic activity. Increased SNS activity is thought to exacerbate the pathogenesis of heart failure through several processes, including fibrosis, deleterious effects on excitation-contraction coupling, and desensitization of cardiac-adrenergic receptors. In diabetes patients with impaired parasympathetic regulation, hypertension is more common. Additionally, there is a connection between this abnormality and vascular problems and a hypertension profile [9-11]

To examine changes in the autonomic nervous system's function in normotensive patients with a familial history of hypertension, research was created. The autonomic nervous systems of 60 normotensives with a background of hypertension and 45 normotensives without a history of the condition were compared. In contrast to the control group, normotensives with a hypertension family history had significantly higher systolic pressure, a smaller proportion and area of the heart's high-frequency band, and lessened baroreflex sensitivity while at rest. They also showed a smaller proportion and area of the heart's high-frequency band when the body was being cooled. Additionally, we demonstrated that the two groups' upright tilting baroreflex sensitivity time courses were different. The variables of systolic bp and the power spectra of microvascular variability, however, did not significantly differ between the two groups. According to our findings, although normotensives with a family background of hypertension display an elevated sympathetic to parasympathetic activity ratio at the cardiac level, they do not demonstrate any change in the sympathetic responsiveness of the vessels and also have a different sympathovagal balance, with less parasympathetic activity at the heart level and more myogenic microvascular reactivity [12-14].

A significant public health issue, hypertension typically operates covertly. It is the result of intricate genetic and environmental interactions. This study's objective is to assess the autonomic nervous system (ANS) in people who are normotensive but have a family history of hypertension. This study's methodology involved testing the autonomic nervous system (ANS) in 30 normotensive individuals with a previous history of hypertension as well as an equal number of controls who did not have a similar family history. In both groups, the parasympathetic portion of the autonomic nervous system operated roughly similarly. However, the participants' sympathetic nervous system was hyperactive, as seen by the larger increase in their diastolic blood pressure in reaction to the prolonged hand grip. The parasympathetic nervous system was unaffected while the sympathetic nervous system was overactive in the normotensive participants in this study who had a familial history of hypertension [15].

Conclusion

The study has concluded that the systolic and diastolic pressure is significantly higher in individuals with a family history of hypertension after performing the cold pressor test and isometric handgrip test ($p<0.05$). Again, heart rate variability is significantly different between the study and control group for each index ($p<0.05$), as compared to age-matched individuals with normotensive parents. However, there is no statistically significant difference in nerve conduction in individuals with hypertensive parents as compared to the normotensive parents. The study, further added that each index in Heart Rate Variability (HRV) was found to be significant in the study group from that of the control group. The authors suggest that there is a need to conduct more studies with similar objectives with a larger and more varied population. Finally, this current study has highlighted the clinically important conclusion that autonomic reactivity can be used to determine potential hypertension as a screening method and to execute preventive lifestyle modifications for the reduction of hypertension episodes in later life of individuals with hypertensive parents.

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