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RESEARCH ARTICLE

Effect of duration of hypertension on heart rate variability

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ABSTRACT

Background: Hypertension is the most prevalent noncommunicable disease. It is a multisystem disorder that affects many organs of the body including cardiovascular system, and it markedly increases both morbidity and mortality in the population. Hypertension causes dysfunction of the cardiac autonomic nervous system leading to sympathovagal imbalance. Heart rate variability (HRV) is a non-invasive tool used to detect variation in RR intervals and has been proposed as early markers of vulnerability to ventricular arrhythmias. The present study was taken up to measure the effect of duration of the hypertension on HRV for early detection and early management of cardiac abnormalities. **Aims and Objectives:** The objectives of the study were to evaluate the effect of duration of the hypertension on cardiac autonomic function in patients with primary hypertension by measuring HRV. **Materials and Methods:** HRV test was performed on 50 male hypertensive patients who were divided into 2 groups, based on the duration of hypertension, i.e., duration of hypertension >5 years and <5 years. All the subjects were in between the age group of 41 and 60 years. Statistical analysis was done using unpaired *t*-test. **Results:** Parameters of frequency-domain analysis of HRV such as low frequency (LF) (Hz), LF (ms^2), and high frequency (nu) were significantly reduced in hypertensives with >5 years duration ($P < 0.01$). Time domain parameters such as root mean square successive differences, triangular interpolation of normal to normal, and percentage of differences between adjacent normal RR interval 50% were reduced in hypertensive subjects with duration >5 years, and it was highly significant. $P < 0.001$ showing decreased in parasympathetic activity in long-standing hypertension. **Conclusion:** Study showed reduced HRV parameters showing decreased parasympathetic activity in long-standing hypertension leading to an imbalance in cardiac autonomic function. It is very much important to evaluate the cardiac autonomic function status in long-standing hypertension using simple non-invasive tools for early detection and treatment of cardiac arrhythmias and other variations in cardiac function status.

KEY WORDS: Hypertension; Time Domain Parameters; Frequency Domain Parameters

INTRODUCTION

Hypertension is the most prevalent noncommunicable disorder in the world. It is a big concern due to the devastating effects and its chronic complications. Hypertension is a multisystem disorder that affects many organs of the body including the cardiovascular system causing coronary heart disease (CHD) and cerebrovascular disorder (CVD). CHD and CVD are the most common causes of death in the world.[1]

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Variation in the time interval between two heartbeats is determined as heart rate variability (HRV). In the past two decades, many studies are done on HRV, and it represents one of the important markers for assessing cardiac autonomic function. HRV is a non-invasive bedside test, so it is practically more feasible to carry out the studies. HRV test

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measures two spectra such as time domain and frequency domain, which helps to analyze the autonomic function of the cardiovascular system. Many studies have shown that HRV is associated with cardiovascular morbidity and mortality.[2-4] Studies have also established that a reduction in HRV can help to determine the development of diabetic neuropathy, as a predictor of hypertension and early diagnosis of arrhythmic complications post-myocardial infarction.

Regulation of cardiac activity is done by various intrinsic and extrinsic mechanisms. Autonomic nervous system mainly regulates heart rate. Sympathetic nervous activity causes a rise in the heart rate and parasympathetic (vagal) lowers the heart rate. When both systems are active, the vagal effects usually dominate.

Among many patient populations, experimental studies have shown that regulation of cardiovascular autonomic system plays an important role in the cause of cardiac disease and deaths.[5,6] Regarding hypertensive patients, a sympathovagal imbalance was determined by HRV which showed sympathetic overactivity and decreased vagal tone.[7] Reduced HRV has been previously reported in adulthood hypertension.[8]

HRV

HRV refers to the variation in time intervals between consecutive heartbeats. This is related to the influence of autonomic nervous system on the sinoatrial (SA) node. The influence of the autonomic nervous system (ANS) on the Sino-Atrial Node depends on many factors such as afferent signals carried from baroreceptors, chemoreceptors, renin-angiotensin-aldosterone system, and respiratory system. Changes in the HRV pattern provide an early and sensitive indicator of any health impairments. Increased in HRV is a sign of good adaptation showing the efficient functioning of autonomic regulatory mechanisms of heart. Whereas, reduction in HRV shows abnormal adaptation of the ANS, indicating the presence of any cardiac autonomic dysfunction. HRV is measured using frequency- and time-domain spectra. Frequency-domain analysis parameters include such as very low frequency (VLF), LF, and high frequency (HF) expressed in Hz and ms^2. LF and HF spectrum refers to parasympathetic modulation. Time-domain parameters includes RR interval, standard deviation of normal to normal intervals (SDNN), root mean square successive differences (RMSSD), (triangular interpolation of NN [TINN] interval histogram), and percentage of differences between adjacent normal RR interval >50 ms (PNN) 50%. Parasympathetic activity is assessed by time-domain parameters such as SDNN, RMSSD, and PNN 50%.[9]

This study was taken up to assess the effect of duration of hypertension on cardiac autonomic function status in hypertensive patients by analyzing HRV for early diagnosis of cardiac abnormalities and providing the treatment to reduce morbidity and mortality.

MATERIALS AND METHODS

A total of 50 male hypertensive patients between age group of 40 and 60 years were selected for the study. Subjects were further divided into two groups based on the duration of hypertension, i.e., duration of hypertension >5 years and <5 years.

Smokers and alcoholics, subjects suffering from diabetes mellitus, symptomatic coronary artery disease, atrial fibrillation, and subjects with secondary arterial hypertension - such as pheochromocytoma and renal artery disease history of drug treatment other than antihypertensive were excluded.

After obtaining Ethical Committee Clearance, the study was taken up. Procedures were explained to all subjects encouraged the subjects for voluntary participation with the freedom to withdraw from the study even after participation whenever they like. Once they are willing for participating in study informed written consent was obtained. A detailed history regarding the duration of hypertension, family history was taken. Physical and clinical examination was done. Then, the subject was advised to take complete bed rest for 20 min without any mental or physical activity. Blood pressure was recorded in the supine position using mercury sphygmomanometer. Subjects were asked to be rested for 10 min, later resting electrocardiogram (ECG) was recorded for 5 min in supine position. ECG was acquired using digital ECG system, using Niviqure software on a Microsoft Window-based computer. The digital ECG system was used to save multiple records and provided with additional filter settings, calculation tools, automated analysis, and auto report generation facilities.

Statistical Analysis

The results were calculated as a mean ± standard deviation. 2 groups were compared using student's *t*-test.

RESULTS

Frequency-domain parameters such as LF (Hz) and LF (ms^2) were significantly reduced in hypertensives with >5 years duration ($P < 0.01$). HF (nu) was significantly reduced in patients with longer duration of hypertension ($P < 0.01$). Mean LF/HF ratio was 0.84 ± 0.31 with hypertension <5 years and 0.98 ± 0.38 in >5 years hypertensive subjects. LF/HF ratio showed no significant change depending on the duration of hypertension. Time-domain parameters such as RMSSD, TINN, and PNN 50% were reduced in hypertensive subjects with duration >5 years, and it was highly significant $P < 0.001$ compared to hypertensives <5 years duration [Tables 1 and 2].

Table 1: Frequency domain parameters of HRV

Measurement	Duration of hypertension			
	<5 years	>5 years	<5 years v/s>5 years	
	Mean±SD	Mean±SD	*t*-value*	*P* level
Peak frequency (Hz)				
VLF	0.02±0.01	0.02±0.01	0.57	0.57 NS
LF	0.06±0.04	0.08±0.03	−2.34	0.02 S
HF	0.26±0.13	0.26±0.15	−0.06	0.96 NS
Peak power (ms^2/Hz)				
VLF	2138.63±590.67	2210.00±514.32	−0.44	0.66 NS
LF	858.00±130.40	696.20±312.40	1.99	0.05 S
HF	323.19±128.80	346.88±194.20	−0.44	0.66 NS
Frequency (nu)				
LF	46.78±13.34	41.27±11.01	1.54	0.13 NS
HF	58.79±16.68	45.67±12.82	3.06	0.00 S
LF/HF	0.84±0.31	0.98±0.38	1.28	0.21 NS

S: Significant difference; NS: Non-Significant difference, SD: Standard deviation, VLF: Very low frequency, LF: Low frequency, HF: High frequency, HRV: Heart rate variability

Table 2: Time domain analysis of HRV

Measurement	Duration of hypertension			
	<5 years	>5 years	<5 years v/s>5 years	
	Mean±SD	Mean±SD	*t*-value*	*P* level
HR/bpm	71.40±7.53	71.328±20	0.04	0.97 NS
SDNN (ms)	58.94±9.11	59.26±9.87	−0.11	0.91 NS
RMSSD	28.40±15.49	14.57±4.89	4.77	0.00 HS
TINN (ms)	179.63±113.29	104.94±41.04	3.43	0.00 HS
RR (ms)	880.90±117.42	833.09±185.20	0.94	0.35 NS
PNN 50%	3.99±1.95	0.47±0.63	9.60	0.00 HS
RR index	0.05±0.01	0.05±0.01	1.78	0.08 NS

RMSSD: Root mean square successive differences, HRV: Heart rate variability, SD: Standard deviation, SDNN: Standard deviation of normal to normal intervals, TINN: Triangular interpolation of NN, PNN: Percentage of differences between adjacent normal RR interval, NS: Non-Significant difference

DISCUSSION

Hypertension is the most prevalent noncommunicable disorder in the world. Over years HRV has gained so much interest due to its non-invasive and bedside procedure for early detection of cardiovascular pathology.

Over six decades, epidemiological studies have proved that increase in heart rate has increased cardiovascular morbidity in cardiovascular patients and also in general population with or without risk factors.[10,11] This study showed elevated heart rate in hypertensive subjects. Increased heart rate is correlated with higher blood pressure. Increased sympathetic tone manifested by higher heart rate is common among hypertensive subjects.[12]

This study showed there was a significant reduction in both frequency-domain and time-domain parameters of HRV test. In this study, LF frequency (Hz) and LF power (ms^2) were significantly reduced in hypertensives with >5 years duration. Similar findings were found in Huikuri *et al*.[13] studies showing in long-standing hypertension there was reduction in VLF and LF components of frequency-domain parameters, indicating that reduced HRV may contribute to increased cardiac morbidity and mortality. Reductions in VLF and LF power spectral components suggested non-invasive markers of risk for cardiac and overall mortality[14] and these parameters can also be used as early indicators for the occurrence of life-threatening arrhythmias.[15,16]

Time-domain spectra of HRV such as RMSSD, TINN, and PNN 50% were reduced in hypertensive subjects with duration >5 years, showing significant lower parasympathetic activity in longer duration.

CONCLUSION

This study concluded that testing cardiovascular autonomic tests is important in hypertensive patients to look for its dysregulation. The effects of cardiovascular reflex can be assessed using HRV test effectively for physiological and clinical investigations by patients bedside, or in the laboratory using more elaborate equipment. Physiologists, clinicians, and medical students can make use of these tests to assess or understand cardiovascular autonomic tests in man in health or disease. As cardiac arrhythmias are associated with a reduction in HRV, indicates the risk for occurrence of cardiac arrhythmias among hypertensive patients. Testing HRV acts as a simple non-invasive bedside test for early detection of any differences in cardiac autonomic balance that may be markers for early cardiac autonomic dysregulation. In this study, there was sympathetic overactivity among hypertensive patients showed that impaired cardiac autonomic function and also showed sympathovagal imbalance in hypertensive patients higher toward sympathetic tone and lower vagal modulation.

In conclusion, testing cardiac function status is an important area of investigation in hypertensive patients, to look for ventricular arrhythmias. These simple non-invasive measures can be used for early detection and treatment of life-threatening arrhythmias and other variations in cardiac autonomic function.

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