OPEN ACCESS
Scholars International Journal of Anatomy and Physiology
Abbreviated Key Title: Sch Int J Anat Physiol
ISSN 2616-8618 (Print) |ISSN 2617-345X (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Study of Heart Rate Variability in Middle-Aged Adults with Hypertension

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DOI: 10.36348/sijap.2021.v04i11.001 | **Received:** 23.10.2021 | **Accepted:** 29.11.2021 | **Published:** 07.12.2021

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Abstract

Introduction: Hypertension is one of the important causes of coronary heart disease and cerebrovascular disease. The autonomic nervous system has a significant role in the circulatory system and blood pressure regulation. Analysis of heart rate variability (HRV) is a non-invasive tool that is widely used to assess autonomic nervous function. ***Aims & Objectives***: The study aimed to analyze HRV in Hypertensive individuals. ***Materials & Methods***: An analytical study was conducted on 50 normotensives and 50 hypertensives in the age group of 40–60 years. Blood pressure was measured by using a sphygmomanometer in sitting position. According to JNC VII criteria, normotensives are those with SBP ≤ 120 mmHg and DBP ≤ 80 mmHg. Hypertensives are those with SBP ≥ 140 mmHg and DBP ≥ 90 mmHg. HRV is measured for 2min using Polar H10 chest strap and data is analyzed using Elite HRV software. In Time-domain methods Mean RR, SDNN, RMSSD, and PNN50 were assessed. In Frequency domain methods LF, HF, and LF/HF were assessed. The data was entered into Excel 2016 and SPSS version 21 was used for analysis. An unpaired "t" test was used to compare the HRV values between normotensive and hypertensive groups. ***Results:*** Mean HR, SDNN, RMSSD, PNN50, and HF were found to be decreased and LF, LF/HF were increased in hypertensives suggesting increased sympathetic activity and reduced parasympathetic activity in hypertensives. All the values were statistically significant ($p<0.01$). ***Conclusion:*** There is increased sympathetic activity and a decreased vagal tone associated with hypertension. Thus HRV can be used as a routine screening test to predict the future risk of hypertension at an earlier stage and also for a better prognosis during treatment.

Keywords: Hypertension, Autonomic nervous system, Heart rate variability, Normotensives, Hypertensives.

INTRODUCTION

Blood pressure is defined as the lateral pressure exerted by the column of blood on the wall of arteries. Blood pressure means arterial pressure which fluctuates during systole and diastole of the heart. It is one of the vital parameters of a human being which is essential for the survival of life.

Hypertension is defined as a persistent elevation of blood pressure to ≥140/90 mmHg [1]. It is one of the most common non-communicable diseases in the world. A mild increase or decrease in blood pressure will not result in significant changes in the body. But when these changes remain for a sustained period of time, almost all of the internal organs which are constantly under the influence of blood pressure get affected resulting in end-organ damage. Hence high blood pressure is often called a silent killer. WHO considers hypertension as one of the most important causes of early death worldwide [2]. It is one of the important causes of coronary heart disease and cerebrovascular disease. Although the pathogenesis of most hypertension is unclear, dysregulation of the autonomic nervous system has been implicated in its development. The Autonomic nervous system has a significant role in the circulatory system and blood pressure regulation. Impaired autonomic nervous system function has been implicated in the development of coronary heart diseases and hypertension. Autonomic modulation of heart rate is assessed by Heart Rate Variability [HRV] [3]. Analysis of heart rate variability is a non-invasive tool that is widely used to assess autonomic nervous function. Heart rate variability is the cardiac beat-to-beat variation. It is caused by variations in the input to the sinoatrial (SA) node from the autonomic nervous system [4].

HRV is the most sensitive indicator of sympathovagal balance. It measures the balance between sympathetic mediators of heart rate, that is the

effect of epinephrine and norepinephrine released from sympathetic nerve fibers acting on the sino-atrial and atrioventricular nodes which increase the heart rate and parasympathetic mediators of heart rate, that is the influence of acetylcholine released by the parasympathetic nerve fibers acting on the sino-atrial and atrioventricular nodes leading to decrease in heart rate[5]. The state of sympathovagal balance is used in the diagnosis of several cardiovascular disorders and many autonomic dysfunctional disorders [6].

AIMS & OBJECTIVES

The study aimed to analyze HRV in Hypertensive individuals and to discuss the significance of HRV in hypertension.

MATERIALS & METHODS

After obtaining clearance from the Institutional ethics committee of Andhra Medical College, Visakhapatnam, an analytical study was conducted on 100 subjects in the age group of 40 – 60 years, attending Medicine OPD, of which 50 are hypertensive patients and 50 are normotensives who were the healthy attendees accompanying the patients. A detailed medical and personal history was taken, informed and written consent was received after explaining in detail the procedure. General and clinical examination was done. Exclusion criteria: Patients on any anti-hypertensive drugs, obese persons with BMI > 30, patients with cardiac diseases, clinical history of cancer, liver cirrhosis and/or failure, narcotic abuse, alcoholics, smokers, and diabetics were excluded from the study.

Blood pressure was measured by using a sphygmomanometer in sitting position. According to JNC VII criteria, normotensives are those with SBP ≤ 120 mmHg and DBP ≤ 80 mmHg. Hypertensives are those with SBP ≥ 140 mmHg and DBP ≥ 90 mmHg. HRV is measured using a Polar H10 chest strap [7]. The Polar H10 chest wrap collects and processes the HRV measurements by detecting the electrical signals of the heart. It is connected to EliteHRV app on the iPad through Bluetooth. The Polar H10 chest strap was fitted around the participant's chest just below the chest muscles with the heart rate sensor placed on the xiphoid process of the sternum. Velcro was sewn onto the reverse side of the chest strap the size could be adjusted for a proper fit around the participant. Once the device connection was confirmed, open readings were commenced by pressing the start button on the EliteHRV app and ECG data was collected for 2 minutes. Time-domain indices and Frequency-domain indices were the Spectral indices of HRV measured. In Time-domain measures, Mean RR, Standard deviation of normal-to-normal RR intervals (SDNN), Root mean square of successive difference (rMSSD), and the proportion of NN50 to the total number of NN intervals (pNN50) are calculated. SDNN, rMSSD, and pNN50 are measures of parasympathetic activity [8]. In Frequency domain measures, Low-frequency power (LF), High-frequency power (HF), Ratio of low-frequency power to high-frequency power (LF/HF) are calculated. HF is a measure of parasympathetic activity and LF and LF/HF ratio are measures of sympathetic activity [8].

STATISTICAL ANALYSIS

The data was entered into Excel 2016 and SPSS version 21 was used for analysis. All the HRV indices were expressed as mean ± SD. An unpaired "t" test was used to compare the values between normotensive and hypertensive groups.

RESULTS

The study results include 50 subjects of a control group who were normotensives between the age group of 40 to 60 years, whose mean age was 47.64 ± 5.55 years, and 50 patients who are hypertensives with the mean age of 50.84 ± 5.74 years. In the study population of the control group, 31(62%) were males and 19(38%) were females and in the hypertensive group 33(66%) were males and 17(34%) were females. Demographic details of the study are placed in Table-1.

Table-1: Showing the distribution of males and females in control and test groups

	NORMOTENSIVES (50)	HYPERTENSIVES (50)
MALES	31 (62%)	33 (66%)
FEMALES	19 (38%)	17 (34%)
MEAN AGE (YEARS)	47.64 ± 5.55	50.84 ± 5.74

The mean SBP in the normotensive group was 111.8 ± 5.76 and the hypertensive group was 154.24 ± 8.96. The mean DBP in the normotensive group was 73.92 ± 4.33 and the hypertensive group was 93.24 ± 5.95. The mean heart rate in the normotensive group was 74.1 ± 5.92 and the hypertensive group was 94.84 ± 7.47.

Table 2: Systolic Blood Pressure, Diastolic Blood Pressure, Mean Heart Rate of normotensives and hypertensive subjects (Values expressed in Mean ± SD)

VARIABLE	NORMOTENSIVES	HYPERTENSIVES
SBP	111.8 ± 5.76	154.24 ± 8.96
DBP	73.92 ± 4.33	93.24 ± 5.95
MEAN HR	74.1 ± 5.92	94.84 ± 7.47

The time-domain indices – mean RR, SDNN, rMSSD, pNN50 were found to be reduced in hypertensives than in normotensives and were statistically significant ($p < 0.01$).

Table 3: Time-domain measures

TIME-DOMAIN	NORMOTENSIVES		HYPERTENSIVES		T VALUE	P-VALUE
	MEAN	SD	MEAN	SD		
MEAN RR	0.748	0.1	0.532	0.083	11.75	<0.001
SDNN	67.2	11.65	26.42	9.53	11.15	<0.0001
RMSSD	60.29	9.45	21.58	10.65	19.22	<0.0001
Pnn50	17.95	10.59	3.24	3.79	9.24	<0.0001

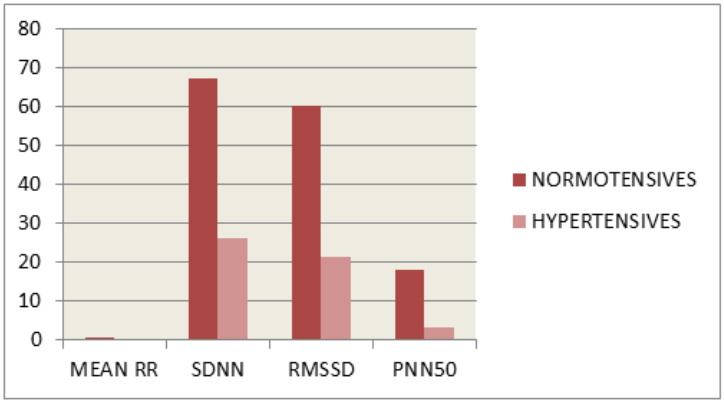

Figure 1: Bar diagram showing Time-domain measures

The frequency-domain measure LF was increased in hypertensives than in normotensives, HF was decreased in hypertensives than in normotensives and the ratio LF/HF was increased in hypertensives. All the values were statistically significant ($p < 0.01$).

Table 4: Frequency-domain measures

FREQUENCY DOMAIN	NORMOTENSIVES		HYPERTENSIVES		T VALUE	P-VALUE
	MEAN	SD	MEAN	SD		
LF	119.12	34.19	223.88	61.77	10.49	<0.0001
HF	200	55.08	110.88	27.21	10.25	<0.0001
LF/HF	0.59	0.17	2.1	0.66	15.66	<0.0001

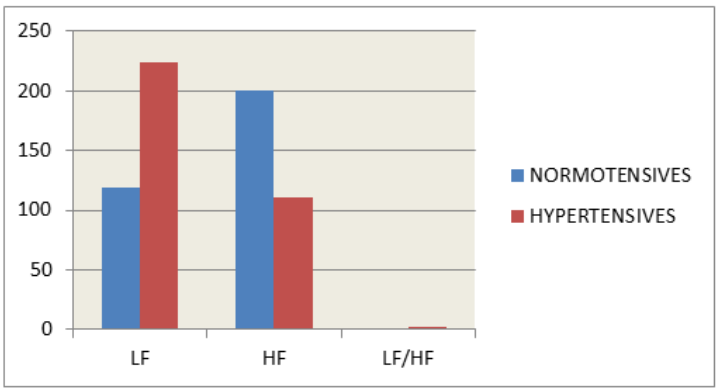

Figure 2: Bar diagram showing Frequency-domain measures

DISCUSSION

HRV is used as a tool in assessing sympathetic and parasympathetic components of the autonomic nervous system. In the present study, time-domain indices were significantly reduced in hypertensives which imply sympathetic overactivity and reduced vagal tone. Similar results were obtained by Radaelli *et al*., 1994, ES Prakash *et al*., 2005.

The mean value of LF was increased in hypertensives suggesting increased sympathetic activity in hypertension. The mean value of HF was reduced in hypertensives suggesting reduced parasympathetic action in hypertension. The LF/HF ratio was higher in hypertensives. Similar results were obtained by Nirmala Natarajan *et al*.,

A study showed that HRV is reduced in patients with systemic hypertension indicating that autonomic dysfunction is present in the initial stage of hypertension [9]. Virtanen R *et al*., found that HRV is significantly reduced in mild or moderate untreated hypertension [10]. Another study reported that adolescents with primary hypertension had lower HF and higher LF and LF/HF ratio indicating sympathetic overactivity and decreased parasympathetic activity [4]. Xie *et al*., reported that decreased HRV in hypertension is a potential pathophysiological mechanism in the development of adulthood cardiovascular diseases [11]. Urooj *et al*., showed that the time domain parameters such as SDNN, rMSSD, and pNN50 were significantly reduced in hypertensives when compared to normal healthy subjects [12]. Menezes JR *et al*., evidenced that there is low HRV in hypertensives and on anti-hypertensive therapy, HRV parameters returned to normal [13].

The results of the present study were similar to previous studies. All the findings suggest that the increased sympathetic and decreased parasympathetic activities occur in hypertensives suggesting sympathovagal imbalance occurring early in the course of hypertension. As the disease progresses, sympathetic activity also increases. Increased sympathetic activity leads to increased systemic vascular resistance which is primarily involved in the development of essential hypertension [14]. Increased sympathetic activity is an important factor involved in the pathophysiology of target organ damage in hypertensives. The study done by Paolo Melillo et al. studied the relationship between HRV and target organ damage in hypertensives [15]. Another important factor contributing to both increased sympathetic activity and cardiovascular dysregulation is stress. A study was done by H Ruediger, in which HRV was calculated in hypertensives and normotensives under mental stress [16]. This study suggested that there is sympathetic overactivity and parasympathetic depression in hypertensives under mental stress than in normotensives. This sympathetic hyperactivity may eventually lead to a sympathovagal imbalance in hypertensives.

In addition, lifestyle is associated with HRV and blood pressure [17]. Alcohol consumption and obesity are key factors associated with elevated blood pressure levels and are linked with increased cardiovascular disease risk. A study conducted by Whitehall II stated that an unhealthy lifestyle including smoking, little or no strenuous exercise, poor diet, high alcohol consumption, and lack of physical activity was associated with adverse HRV [18].

CONCLUSION

There is increased sympathetic activity and a decreased vagal tone associated with hypertension. Thus HRV can be used as a routine screening test to predict the future risk of hypertension at an earlier stage and also for a better prognosis during treatment.

REFERENCES

1. Faculty of Public Health/Hypertension - the “Silent killer” www.fph.org.uk/uploads/br-hypertension.pdf
2. Mackay, J., & Mensah, G. (2004). Atlas of heart disease and stroke. Geneva: World Health Organization.
3. Shaffer, F., McCraty, R., & Zerr, C. L. (2014). A healthy heart is not a metronome: an integrative review of the heart's anatomy and heart rate variability. *Frontiers in psychology*, *5*, 1040.
4. Havlicekova, Z., Tonhajzerova, I., Jurko Jr, A., Jesenak, M., Durdik, P., Nosal, S., ... & Bánovcin, P. (2009). Cardiac autonomic control in adolescents with primary hypertension. *European journal of medical research*, *14*(4), 1-3.
5. Nasim, K., Jahan Ara, H., & Syed Sanowar, A. (2011). Heart rate variability-a review. *Journal of Basic and Applied Sciences*, 7, 71-77.
6. Lehrer, P. M., & Gevirtz, R. (2014). Heart rate variability biofeedback: how and why does it work?. *Frontiers in psychology*, *5(1)*, 756.
7. Gilgen-Ammann, R., Schweizer, T., & Wyss, T. (2019). RR interval signal quality of a heart rate monitor and an ECG Holter at rest and during exercise. *European journal of applied physiology*, *119*(7), 1525-1532.
8. Pal, G. K., & Parvati, P. (2010). Spectral analysis of Heart Rate Variability. Textbook of Practical Physiology 5rd edition Universities Press; Chapter 37, 259-268.
9. Singh, J. P., Larson, M. G., Tsuji, H., Evans, J. C., O’Donnell, C. J., & Levy, D. (1998). Reduced heart rate variability and new-onset hypertension: insights into pathogenesis of hypertension: the Framingham Heart Study. *Hypertension*, *32*(2), 293-297.
10. Virtanen, R., Jula, A., Kuusela, T., Helenius, H., & Voipio-Pulkki, L. M. (2003). Reduced heart rate

variability in hypertension: associations with lifestyle factors and plasma renin activity. *Journal of human hypertension*, *17*(3), 171-179.

11. Xie, G. L., Wang, J. H., Zhou, Y., Xu, H., Sun, J. H., & Yang, S. R. (2013). Association of high blood pressure with heart rate variability in children. *Iranian journal of pediatrics*, *23*(1), 37-44.
12. Urooj, M., Pillai, K. K., Tandon, M., Venkateshan, S. P., & Saha, N. (2011). Reference ranges for time domain parameters of heart rate variability in indian population and validation in hypertensive subjects and smokers. *Int J Pharm Pharm Sci*, *3*(1), 36-39.
13. Menezes Jr, A., Oliveira, L., Melo, C., & Freitas Jr, A. F. (2000). Heart Rate Variability and Autonomic Nervous System Response in Hypertensive Patients with and without ACE Inhibitors Treatment. *Progress in Biomedical research*, 1, 385-388.
14. Scott, G. Pathophysiology of Hypertension. Tufts University, School of Medicine. www.ocw.tufts.edu/data/33/498002.pdf
15. Melillo, P., Izzo, R., De Luca, N., & Pecchia, L. (2012). Heart rate variability and target organ damage in hypertensive patients. *BMC cardiovascular disorders*, *12*(1), 1-11.
16. Ruediger, H., Seibt, R., Scheuch, K., Krause, M., & Alam, S. (2004). Sympathetic and parasympathetic activation in heart rate variability in male hypertensive patients under mental stress. *Journal of human hypertension*, *18*(5), 307-315.
17. Thayer, J. F., Yamamoto, S. S., & Brosschot, J. F. (2010). The relationship of autonomic imbalance, heart rate variability and cardiovascular disease risk factors. *International journal of cardiology*, *141*(2), 122-131.
18. Hemingway, H., Shipley, M., Brunner, E., Britton, A., Malik, M., & Marmot, M. (2005). Does autonomic function link social position to coronary risk? The Whitehall II study. *Circulation*, *111*(23), 3071-3077.