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Research Article

A study on analysis of Heart Rate Variability in hypertensive individuals

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Abstract

Introduction: Hypertension is a major risk factor for coronary artery disease, stroke and heart failure. Autonomic nervous system (ANS) dysfunction is an important factor in the development and progression of hypertension. Heart rate variability (HRV) is a simple, sensitive and non-invasive tool to monitor the cardiovascular ANS function. Thus, the present study was chosen as a simple tool to assess the sympathovagal balance by analysing the HRV changes in hypertensive individuals.
Aims & Objectives: To analyse Heart Rate Variability (HRV) in hypertensive individuals.
Materials & Methods: The study was conducted on 30 normotensive and 30 hypertensive subjects (BP≥140/90 mm Hg, according to JNC-7 classification). Lead-II ECG was recorded using the instrument PHYSIOPAC-PP4, MEDICAID system, Chandigarh and HRV analysis was done using Kubios HRV analyser. Spectral indices of HRV such as total power (TP), normalized low frequency power (LFnu), normalized high frequency power (HFnu), ratio of low frequency power to high frequency power (LF-HF ratio), standard deviation of normal-to-normal RR intervals (SDNN), root mean square successive difference (rMSSD) and the proportion of NN50 to the total number of NN intervals (pNN50) were assessed.
Results: Our results showed significantly reduced HFnu ($p<0.05$), SDNN ($p<0.05$), rMSSD ($p<0.05$) and pNN50 ($p<0.05$) in hypertensive individuals. LFnu and LF-HF ratio was significantly increased ($p<0.05$) in hypertensive individuals.
Conclusion: There is an 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

1. Introduction

Hypertension is defined as a persistent elevated blood pressure of ≥140/90 mmHg[1]. It is one of the most prevalent diseases worldwide. The prevalence of hypertension in South Indian population is around 22.1% [2]. There are many modifiable risk factors underlying hypertension such as increased body weight, reduced physical activity, high salt intake, alcohol consumption and low potassium intake. Hypertension is a major risk factor for many cardiovascular diseases like coronary artery disease, stroke, heart failure and end-stage renal disease[3]. It has been estimated that hypertension accounts for 6% of death worldwide[4]. Thus, primary prevention of hypertension may reduce the overall risk of cardiovascular diseases.

Blood pressure is maintained physiologically by multiple regulatory mechanisms such as neural control, hormonal control and local control mechanism. Among them, neural control by Autonomic nervous system (ANS) is the most important regulatory mechanism of blood pressure. Though hypertension is a multifactorial disease, ANS dysfunction is an important factor in the development and progression of hypertension [5].

Heart-rate variability (HRV) is defined as the oscillation of heart rate around the mean value. It is caused by variations in the input to the sinus node from the autonomic nervous system[6]. It is a simple, sensitive and non-invasive tool to monitor the cardiovascular ANS function. It is a measure of the balance between sympathetic mediators of heart rate that is the effect of epinephrine and norepinephrine released from sympathetic nerve fibres acting on the sino-atrial and atrio-ventricular nodes which increase the heart rate and parasympathetic mediators of heart rate that is the influence of acetylcholine released by the parasympathetic nerve fibres acting on the sino-atrial and atrio-ventricular nodes leading to a decrease in the heart rate[7]. HRV analysis thus can identify any change in sympathovagal balance.

Thus, the present study was chosen as a simple tool to assess the sympathovagal balance by analysing the HRV changes in hypertensive individuals.

2. Materials and methods

After obtaining clearance from the Institutional ethical committee of Sri Venkateshwara Medical College and Research Centre, 30 normotensive and 30 hypertensive individuals were recruited for the study. The subjects were recruited from Medicine OPD as well as the staffs of our college and hospital. Blood pressure was recorded with standard mercury sphygmomanometer in sitting posture after 5 mins of rest. The criteria for diagnosing hypertension were BP ≥140/90 mmHg based on the average of 3 consecutive readings at an interval of 3 weeks[8]. Subjects in the age group 25-55 years of both the sexes with BP values of 100-119/60-79 mm Hg will be recruited as normotensives (group I) and BP values of ≥ 140/90 mm Hg will be recruited as hypertensives (group II), according to JNC-7 classification[9]. Exclusion criteria: Patients on any anti-hypertensive drugs, persons with BMI > 30, patients with cardiac diseases, alcoholics, smokers and diabetics were excluded from our study.

Informed consent was obtained from all the subjects prior to the study. After 15 minutes of rest, 5 minutes of ECG recording was done in supine position in our Physiology research lab, in the morning time (room temperature maintained at 20-25ºC) using the instrument PHYSIOPAC-PP4, MEDICAID SYSTEM, CHANDIGARH. The data analysis was then done using the Kubios HRV analyser. The spectral indices of HRV assessed were [10]:

1. Time domain measures:

a) Standard deviation of normal-to-normal RR intervals (SDNN)
b) Root mean square successive difference (rMSSD)
c) The proportion of NN50 to the total number of NN intervals (pNN50)

SDNN, rMSSD and pNN50 are measures of parasympathetic activity [10].

2. Frequency domain measures:

a) Normalized low frequency power (LFnu)
b) Normalized high frequency power (HFnu)
c) Ratio of low frequency power to high frequency power (LF-HF ratio)

HFnu is a measure of parasympathetic activity and LFnu and LF/HF ratio are measures of sympathetic activity [10].

2.1 Statistical analysis

The data was analyzed using SPSS version 17. All the HRV measures were expressed as mean±SD. Unpaired "t" test was used to compare the values between normotensive and hypertensive groups.

3. Results

1. The time domain measures SDNN, rMSSD and pNN50 were all significantly reduced ($p<0.05$) in hypertensive patients when compared to normotensives.
2. The frequency domain measures HFnu was significantly reduced ($p<0.05$) and LFnu and LF/HF ratio was significantly increased ($p<0.05$) in hypertensive patients when compared to normotensives.

The HRV values of hypertensive group were compared with the normotensive group.

Table 1: Time domain measures

	Normotensive (n=30)	Hypertensive (n=30)
SDNN (ms)	158.96±18.84	147.49±15.68 *
rMSSD (ms)	45.78±10.61	39.6±12.83 *
pNN50	16.47±6.91	9.63±5.82 *

*p<0.05- significant

Table 2: Frequency domain measures

	Normotensive (n=30)	Hypertensive (n=30)
LFnu	77.63±19.39	88.45±12.32 *
HFnu	58.76±14.89	36.68±11.14 *
LF/HF ratio	2.76±1.18	4.84±1.93 *

* p<0.05- Significant

4. Discussion

In the present study, LFnu and LF/HF ratio was significantly increased in hypertensives. This suggests that there is increased sympathetic activity in hypertensives. HFnu and time domain measures SDNN, rMSSD and pNN50 were significantly reduced in hypertensives, suggestive of decreased parasympathetic activity in hypertensives.

A study showed that HRV is reduced in patients with systemic hypertension suggesting that autonomic dysfunction is present in the early stage of hypertension[11]. Virtanen R et al. found that HRV is significantly lower in mild or moderate untreated hypertension[12]. Another study revealed that adolescents with primary hypertension had lower HF and higher LF and LF/HF ratio suggesting sympathetic predominance and reduced vagal activity[6]. Xie et al. reported that HRV reduced in hypertension is a potential pathophysiological mechanism in the development of adulthood cardiovascular diseases[13]. Urooj et al. showed that the time domain parameters such as SDNN, rMSSD and pNN50 were significantly reduced in hypertension compared to normal healthy subjects[14]. Menezes JR et al. evidenced that there is low HRV in hypertensives and on anti-hypertensive therapy, HRV parameters returned back to normal [15].

The results of our study were similar to the previous studies. Thus, our findings suggest that there is sympathovagal imbalance occuring in hypertensives.

The pathophysiology of essential hypertension is primarily due to an increase in systemic vascular resistance. This is mainly attributed to the enhanced activity of sympathetic nervous system[16]. The sympathetic hyperactivity might be due to baroreceptor resetting that causes suppression of sympathetic inhibition[17]. There is also evidence of norepinephrine spillover into the circulation in essential hypertension that leads onto sympathetic hyperactivity[18]. Experimental studies have shown increased Angiotensin II level in blood which can stimulate the secretion of catecholamines[18]. Angiotensin II also causes oxidative stress that leads onto interaction of reactive oxygen species (O^-) with nitric oxide (NO) causing reduced levels of NO which results in vasoconstriction[18]. Local factors like endothelin might also be the contributing factor for adrenergic activation characterizing hypertension[17]. This sympathetic hyperactivity eventually may lead onto sympathovagal imbalance in hypertensives.

5. Conclusion

- There is an 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.

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