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Original Research Article

A Comparative Study of Heart Rate Variability between Hypertensive and Normotensive Subjects in Western Rajasthan

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Abstract: Hypertension is the most common disease and it markedly increases both mortality and morbidity. The adverse effects of hypertension principally involve the blood vessels, the retina, the heart and the kidneys including central nervous system. The study group includes 30 hypertensive male subjects in the age group of 30-60 years attending Medicine OPD of M.G.H. Hospital, Jodhpur and 30 ages matched normotensive male subjects from general population and healthy attendants of patients visiting M.G.H. Hospital, Jodhpur. The increase in the systolic blood pressure, diastolic blood pressure, pulse pressure and mean arterial pressure in hypertensive subjects compared to normotensive subjects was highly significant.
Keywords: blood pressure, ECG, body, mass index.

INTRODUCTION:

Hypertension is an elevated arterial pressure 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[1]. It is an iceberg disease [2]. Hypertension is a chronic condition which doubles the risk of cardiovascular disease, including coronary heart disease, congestive heart failure, ischemic and hemorrhagic stroke, renal failure and peripheral arterial disease. In addition, rare endocrine disorders may present with hypertension. Hypertension is therefore of interest to any physician involved in clinical medicine. It is one of the major risk factors for cardiovascular mortality, which accounts for 20-50% of all deaths [3]. Although our understanding of the pathophysiology of hypertension has increased over several decades, the etiology of essential hypertension with no definable cause continues to be an enigma both to clinicians and physiologists. In a review of physiological aspects of essential hypertension, Folkow has suggested four major strongly dependent causative elements viz. phylogenetically transferred predisposition, environmental factors, neurogenic excitatory influences, early structural adaptation of heart and blood vessels [4]. Approximately 40-60% is explained by genetic factors. Important environmental factors include a high salt intake, heavy consumption of alcohol, obesity, lack of exercise [5].

MATERIAL AND METHODS:

The present study was conducted in M.G.H. Hospital an associated group of hospital, Dr. S. N. Medical College, Jodhpur. The study group includes 30 hypertensive male subjects in the age group of 30-60 years attending Medicine OPD of M.G.H. Hospital, Jodhpur and 30 age matched normotensive male subjects from general population and healthy attendants of patients visiting M.G.H. Hospital, Jodhpur.

All subjects were explained about the procedures to be undertaken and written informed consent was obtained from all the subjects prior to the study. BP values of 100-119/60-79 mm Hg was recruited as normotensives and BP values of ≥ 140/90 mm Hg was recruited as hypertensives, according to JNC-7 classification. Physical examination was done. Height and weight was noted and BMI was calculated as per Quetlets index [2].

Body mass index =	Weight(kilogram) / Height^2 (meter)

All the subjects were clinically examined and detailed history with reference to duration of hypertension, family history, and personal history such as smoking, alcoholism any previous drug history etc was taken on a printed proforma.

Inclusion Criteria:

- 30-60 years normotensive male subjects.
- 30-60 years hypertensive male subjects.

Exclusion Criteria:

- Age less than 30 years and more than 60 years.
- Subjects with diabetes mellitus, congestive cardiac failure and symptomatic coronary artery disease.
- Smokers and alcoholics.
- History of drug treatment other than antihypertensive.

Recording of Blood Pressure:

Test was performed in the morning hours of OPD. Blood pressure was recorded with standard mercury sphygmomanometer in sitting posture after 5 minutes of rest. Three readings were taken and average of second and third was used for study.

RESULT:

Table 1: Comparison of Anthropometric Parameters between Normotensive and Hypertensive Subjects

	Normotensive subjects		**Hypertensive subjects**		**Normotensive subjects Vs Hypertensive subjects**	
	Mean	**SD**	**Mean**	**SD**	**t-value***	**p-value**
Age (yrs)	43.6	8.8	45	7.6	0.51	0.605 NS
Height (mt)	1.61	0.05	1.63	0.05	1.48	0.141 NS
Weight (kg)	61.8	4.19	64	5.59	1.62	0.110 NS
BMI (kg/m^2)	23.79	1.8	24.08	2.02	0.589	0.558 NS

* Unpaired t-test
NS – Not significant

30 normotensive males and 30 hypertensive males were analyzed for the results (Graph 1). The age of subjects ranged from 30-60 years. The results obtained were expressed as Mean ± Standard deviation. On analysis of anthropometric parameters of the 30 normotensive subjects, the mean age (years) was 43.6 ± 8.8; the mean height (m) is 1.61 ± 0.05; the mean weight (kg) was 61.8 ± 4.19; the mean BMI (kg/m^2) was 23.79 ± 1.8 (Table1).

On analysis of anthropometric parameters of the 30 hypertensive subjects, the mean age (years) was 45 ± 7.6; the mean height (m) was 1.63 ± 0.05; the mean weight (kg) was 64 ± 5.59; the mean BMI (kg/m^2) was 24.08 ± 2.02 (Table 1). Statistical analysis was done by Tukey's test.

Table 2: comparison blood pressure parameters between normotensive and hypertensive subjects

	Normotensive subjects		**Hypertensive subjects**		**Normotensive subjects Vs Hypertensive subjects**	
	Mean	**SD**	**Mean**	**SD**	**t-value***	**p-value**
Systolic BP (mm Hg)	120	9.4	148.8	7	13.39	0.0001 HS
Diastolic BP (mmHg)	77.9	5	90	3.6	10.62	0.0001 HS
Pulse Pressure(mm Hg)	41.9	7.83	59	6.5	9.01	0.0001 HS
Mean Arterial Pressure (mm Hg)	91.83	5.69	109.3	3.9	13.83	0.0001 HS

* Unpaired t-test, HS- Highly significant

The mean systolic blood pressure (mm Hg) in normotensive subjects was 120 ±9.4. The mean systolic blood pressure (mm Hg) in hypertensive subjects was 148.8 ±7 (Table 2). The mean diastolic blood pressure in normotensive subjects was 77.9 ± 5. The mean diastolic blood pressure in hypertensive subjects was 90 ±3.6 (Table 2).

The mean pulse pressure in normotensive subjects was 41.9 ± 7.83. The mean pulse pressure in hypertensive subjects was 59 ± 6.5 (Table 2). The mean of mean arterial pressure in normotensive subjects was 91.83 ± 5.69. The mean of mean arterial pressure in hypertensive subjects was 109.03 ± 3.9 (Table 2). The increase in the systolic blood pressure, diastolic blood pressure, pulse pressure and mean arterial pressure in hypertensive subjects compared to normotensive subjects was highly significant ($p < 0.001$) (Table 2)

Table 3: Comparison of Spectral Analysis of Heart Rate Variability Parameters between Normotensive and Hypertensive Subjects

Parameters		Normotensive subjects		Hypertensive subjects		Normotensive subjects Vs Hypertensive subjects	
		Mean	SD	Mean	SD	t-value*	p-value
Peak Frequency (Hz)	VLF	0.01	0.01	0.01	0.01	0.339	0.739 NS
	LF	0.08	0.03	0.06	0.02	2.738	0.008 HS
	HF	0.26	0.11	0.24	0.15	0.588	0.558 NS

* Unpaired t-test, HS- Highly significant, S- Significant, NS-Not significant

Table 4: Comparison of Spectral Analysis of Heart Rate Variability Parameters between Normotensive and Hypertensive Subjects

Parameters		Normotensive subjects		Hypertensive subjects		Normotensive subjects Vs Hypertensive subjects	
		Mean	SD	Mean	SD	t-value*	p-value
Peak Power ($msec^2/Hz$)	VLF	2350	323.5	2171	553.7	1.529	0.131 NS
	LF	996	401	752	306	2.647	0.010 S
	HF	364.8	229.1	344.96	191.67	0.364	0.716 NS

* Unpaired t-test, S- Significant, NS-Not significant

Table 5: Comparison of Spectral Analysis of Heart Rate Variability Parameters between Normotensive and Hypertensive Subjects

Parameters		Normotensive subjects		Hypertensive subjects		Normotensive subjects Vs Hypertensive subjects	
		Mean	SD	Mean	SD	t-value*	p-value
Frequency in normalized units (nu)	LF	49.72	17.66	41.88	11.96	2.014	0.048 S
	HF	47.43	18.73	48.6	16	0.257	0.797 NS
	LF/HF	1.76	0.8	0.94	0.4	5.095	0.0001 HS

* Unpaired t-test, HS- Highly significant, S- Significant, NS-Not significant

Table 6: comparison of time domain analysis of heart rate variability between normotensive and hypertensive subjects

Parameters	Normotensive subjects		Hypertensive subjects		Normotensive subjects Vs Hypertensive subjects	
	Mean	SD	Mean	SD	t-value*	p-value
SDNN (ms)	66.61	9.8	59.55	10.26	2.727	0.008 S
RR (ms)	961.51	139.41	876.44	130.29	2.442	0.0177 S
PNN 50%	6.48	2.92	1.47	1.99	7.761	0.0001 HS
RMSSD	30.06	15.06	16.2	6.7	4.604	0.0001 HS
HR/bpm	65.42	8.77	70.86	8.32	2.463	0.0168 S
RRΔ Index	0.07	0.02	0.05	0.01	4.072	0.0001 HS
TINN (ms)	253.7	161	132	96	3.556	0.0008 HS

* Unpaired t-test, HS- Highly significant, S- Significant

Table 7: Comparison of Spectral Analysis of Heart Rate Variability Depending On Duration of Hypertension

Parameters		Duration of Hypertension					
		<5 yrs		>5 yrs		<5 yrs Vs >5 yrs	
		Mean	SD	Mean	SD	t-value*	p-value
Peak Frequency (Hz)	VLF	0.01	0.01	0.01	0.01	0.534	0.597 NS
	LF	0.08	0.04	0.05	0.01	2.596	0.0149 S
	HF	0.24	0.14	0.24	0.15	0.026	0.978 NS

* Unpaired t-test, S- Significant, NS – Not significant

Table 8: comparison of spectral analysis of heart rate variability depending on duration of hypertension

Parameters		Duration of Hypertension					
		<5 yrs		>5 yrs		<5 yrs Vs >5 yrs	
		Mean	SD	Mean	SD	t-value*	p-value
Peak Power ($msec^2/Hz$)	VLF	2023.6	669	2234	501.5	0.954	0.347 NS
	LF	925	116	678	333.8	2.147	0.0406 S
	HF	347	158.4	344	207.9	0.037	0.970 NS

* Unpaired t-test, S- Significant, NS – Not significant

Table 9: **comparison of time domain analysis of heart rate variability depending on duration of hypertension**

Parameters	Duration of Hypertension					
	<5 yrs		>5 yrs		<5 yrs Vs >5 yrs	
	Mean	SD	Mean	SD	t-value*	p-value
SDNN (ms)	60.01	10.18	59.35	10.53	0.159	0.874 NS
RR (ms)	889.45	103.38	870.86	142.24	0.352	0.727 NS
PNN 50%	3.78	2.18	0.48	0.63	6.456	0.0001 HS
RMSSD	21.35	8.72	14.29	4.54	2.933	0.006 HS
HR/bpm	71.52	8.39	70.58	8.48	0.279	0.781 NS
RRΔ Index	0.05	0.02	0.04	0.01	1.34	0.190 NS
TINN (ms)	202.89	145	102	42.42	2.966	0.006 HS

* Unpaired t-test, HS- Highly significant, S- Significant, NS – Not significant

DISCUSSION AND CONCLUSIONS:

Hypertension is the most prevalent non communicable disorder in the world. It is a big concern because of the devastating effects of its chronic complications. Hypertension is a multisystem disorder that affects many organs of the body including cardiovascular system [1]. Cardiac function is regulated by various intrinsic and extrinsic mechanisms. Heart rate is regulated mainly by the autonomic nervous system. Sympathetic nervous activity increases the heart rate, where as parasympathetic (vagal) activity decreases heart rate. When both systems are active, the vagal effects usually dominate. The following reflexes regulate heart rate: baroreceptor, chemoreceptor, pulmonary inflation, atrial receptor (Bainbridge) and ventricular receptor reflexes [7-10]. This study "A comparative study of heart rate variability between hypertensive and normotensive subjects in western Rajasthan" analyzes the effect of hypertension on cardiac autonomic functions of hypertension patients. Heart rate variability test was performed on 60 male subjects who were divided into 2 groups, 30 hypertensive subjects and 30 normotensive subjects. All the subjects were in between the age group of 30-60 years. Hypertensive subjects were again grouped into two groups based on the duration of hypertension i.e., duration of hypertension more than 5 years and less than 5 years. The differences in the mean value of each parameter between hypertensive subjects and normotensive subjects and the difference between each parameter in hypertensive patients based on duration of hypertension were analyzed and discussed

FREQUENCY DOMAIN ANALYSIS

Very low frequency (VLF):

In our study there was no statistically significant change in very low frequency values between hypertensive and normotensive subjects

Low frequency (LF):

In our study, there was a statistically significant reduction in the value of LF peak frequency (Hz), LF power (ms^2) and LF (nu) in hypertensive subjects compared to normotensive subjects. Some studies reported controversial results in Frequency domain analysis of heart rate variability in hypertensive individuals. Usually, the LF spectrum is said to be modulated by sympathetic and parasympathetic activities. Our findings regarding LF may be consequent to the reduction observed in the parasympathetic activity in hypertensive individuals. Some studies reported that when the heart rate varied under strictly controlled circumstances the LF spectrum was mainly influenced by sympathetic activity. However other data suggest that the heart rate variability is calculated under unrestricted conditions, the LF spectrum reflects mainly the parasympathetic activity, in accordance with our findings.

High frequency (HF):

In our study, there was reduction in high frequency values in hypertensive subjects but it was not statistically significant compared to normotensive subjects. High frequency measures parasympathetic activity and our study showed there was reduction in parasympathetic activity in hypertensive subjects.

LF/HF ratio:

In our study there was a statistically significant reduction in LF/HF ratio in hypertensive subjects compared to normotensives. LF/HF ratio measures the sympathovagal balance. Our study showed there was sympathovagal imbalance in hypertensive subjects compared to normotensives.

TIME DOMAIN ANALYSIS:

Heart rate (bpm):

In our study, there was significantly increased heart rate in hypertensives compared to normotensives. Fast resting heart rate is significantly correlated with higher blood pressure, and increased heart rate is prospectively related to the development of hypertension. Individuals with hypertension have increased sympathetic tone manifested by higher heart rate.

SDNN (ms):

In our study there was a statistically significant reduction in SDNN (ms) in hypertensive subjects compared to normotensives.

RR (ms):

In our study RR (ms) interval in normotensive subjects was significantly reduced in hypertensive compared to normotensive subjects.

RMSSD:

In our study RMSSD was significantly reduced in hypertensives compared to normotensives. Decreased values of SDNN, RMSSD indicating decreased HRV and lower RR interval and higher heart rate are suggestive of decrease vagal modulation and higher sympathetic activity in essential hypertension.

PNN 50%:

In our study PNN 50% was significantly reduced in hypertensive subjects compared to normotensives. PNN 50% is a sensitive measure of parasympathetic activity; it was lower among hypertensive subjects, indicating decreased vagal tone.

RR Δ index:

In our study, RR index was significantly reduced in hypertensive subjects.

TINN (ms):

In our study, TINN (ms) value in hypertensives was significantly reduced. RR □□index and TINN (ms) represents the parasympathetic activity and they are significantly reduced in hypertensives.

Duration of hypertension:

In our study LF frequency (Hz) and LF power (ms^2) was significantly reduced in hypertensives with more than 5 years duration.

In long standing hypertension there was reduction in very low and low frequency power spectrum components, suggesting that low HR variability may contribute to increased cardiac mortality.

RMSSD, TINN, PNN 50% was reduced in hypertensive subjects with duration more than 5 years, showing significant lower parasympathetic activity in longer duration.

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