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Original Research Article

COMPARISON OF CARDIAC AUTONOMIC ACTIVITY BETWEEN OFFSPRINGS OF NORMOTENSIVE PARENTS AND HYPERTENSIVE PARENTS

Ashwani Sharma [*1], Rajesh Misra [2], Kiran Singh [3].

[*1] Ph.D. Scholar, Department of Physiology, Subharti Medical College, Meerut, India.

[2] Professor, Department of Physiology; Principal, Shridev Suman Subharti Medical College, Dehradun, India.

[3] Professor & Head, Department of Physiology, Subharti Medical College, Meerut, India.

ABSTRACT

Hypertension is a disease which affects almost entire organ systems of the body therefore it becomes essential to diagnose hypertension at an early stage so that the preventive measures can be employed. Heart Rate Variability (HRV) is used for the prediction, diagnosis and prevention of many cardiovascular dysfunctions. The aim of this study was to record basal Heart Rate (HR), Blood Pressure (BP) and HRV in offsprings of normotensive parents and hypertensive parents and compare the results between these two groups. This study was conducted on 200 subjects of age between 18 to 26 years. They were divided into two groups: control group (100; offsprings of normotensive parents) and study group (100; offsprings of hypertensive parents). The HR and BP values were measured by automatic heart rate and blood pressure measuring machine, Accusure TD 3127, Taiwan whereas HRV was recorded using RMS Polyrite D, (version 2.4), India in both the groups. Statistical analysis was done by student's unpaired t-test using GraphPad Prism 5 software version 5.03 and P values less than 0.05 was considered to be statistically significant. The HR and BP values were high in study group in respect to control group but were not statistically significant. HRV analysis has two components: time domain and frequency domain. The values of time domain parameters were insignificantly less in study group compared to control group but only Standard Deviation of Normal-to-Normal intervals (SDNN) was found to be highly statistically significant. Among the frequency domain, Low and High Frequency in normalized units (LFnu & HFnu) were statistically higher and lower respectively in study group when compared to control group. Our results indicate that there was an increased sympathetic and decreased parasympathetic activity in the study group at resting level. These findings are an early marker of cardiovascular impairment in individuals with parental history of hypertension.

KEY WORDS: Blood Pressure, Cardiac Autonomic Activity, Heart Rate Variability

Address for correspondence: Ashwani Sharma, Ph.D. Scholar, Department of Physiology, Subharti Medical College, Swami Vivekanand Subharti University, N.H.-58, Delhi-Haridwar Bypass Road, Meerut – 250005, Uttar Pradesh (India). **E-Mail:** sharmaphysio2009@gmail.com

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BACKGROUND

Hypertension is an important public health challenge in both developing and developed countries. Raised blood pressure is one of the leading factor to which 13% of global deaths are attributed. It is reported to be the fourth contributor to premature death in developed countries and the seventh in developing countries [1].

Hypertension has been identified as major risk

factor for various cardiovascular disorders and its burden is increasing disproportionately in developing countries as they undergo demographic transition [2].

The prevalence of hypertension in the last six decades has increased from 2% to 25% among urban residents and from 2% to 15% among the rural residents in India. According to Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India, the overall prevalence of hypertension in India by 2020 will be 159.46/1000 population [3] and cardiovascular diseases are estimated to be responsible for 1.5 million deaths annually [4].

Hypertension is defined as "systolic blood pressure equal to or greater than 140 mmHg and/ or diastolic blood pressure equal to or greater than 90 mmHg''. Recently, the JNC 7 (Seventh Report of the Joint National Committee on Prevention, Evaluation and Treatment of High Blood Pressure) introduce the term "Prehypertension" for Systolic Blood Pressure (SBP) levels of 120-139 mmHg and Diastolic Blood Pressure (DBP) levels of 80-89 mmHg. The cut off values for normal blood pressure have been revised to 120/80 mmHg. Hypertension is frequently termed the "silent killer", since it often presents with no apparent signs and symptoms [5].

This disease is known to have many deleterious effects on the body and is considered one of the most important modifiable risk factor for various cardiovascular diseases [6].

Age, sex, mental stress, smoking and obesity are some common factors which play a major role in the development of the hypertension [7].

Several studies have assessed sympathovagal imbalance in hypertensive patients [8-9] and sustained sympathetic over activity has been reported as among the primary mechanisms for genesis of hypertension [10-13].

HRV is a non-invasive electrocardiograph marker reflecting the activity of the sympathetic and parasympathetic branches of the autonomic nervous system on the sinus node of the heart. Spectral analysis of HRV indices has been proposed as the most valuable tool for the assessment of cardiac autonomic imbalance [14-17].

Therefore in the present study, we have analyzed the time domain and frequency domain indices of HRV in the offsprings of normotensive parents and offsprings of hypertensive parents to find out there is any autonomic imbalance between the two groups.

METHODOLOGY

Before initiation of the study, approval was obtained from the Ethical Clearance Committee of Swami Vivekanand Subharti University, Meerut (U.P.), India. The students studying at undergraduate level in Swami Vivekanand Subharti University, Meerut were selected as subjects and entire study was conducted in the Research Laboratory of Physiology Department at Subharti Medical College, Meerut, (U.P.), India. A total of 200 apparently healthy male subjects in the age group between 18 to 26 years were selected for the study and were classified into two groups:

Control group: 100; offsprings of normotensive parents.

Study group: 100; offsprings of hypertensive parents whose parents, either father or mother or both were hypertensive.

The study protocol was explained to the participants after obtaining their written consent and their parental history of hypertension were obtained from medical prescription of the parents along with the prescribed dosage, duration and type of anti-hypertensive therapy. A detailed history and general examination was done to exclude subjects satisfying exclusion criteria. The subjects were asked to report in the Research Laboratory of Physiology Department in the morning between 9 to 11 a.m. after having light breakfast without tea, coffee or other caffeinated beverages such as coke etc. 2 hours prior to recordings. The HR, SBP, DBP and HRV parameters were recorded in both control group and study group for baseline comparison.

Exclusion criteria (common to both control group and study group):

Subjects with any clinical signs and symptoms related to cardiovascular, respiratory, renal, endocrine disorders or taking any medications that affect autonomic nervous system physiology, practicing yoga or exercise, orthopedic problems such as joint and muscle pathologies,

physical disability, smokers and alcoholic were excluded from the present study.

Recording of heart rate and blood pressure: The HR and BP were measured through automatic heart rate and blood pressure measuring machine (Accusure TD 3127, Taiwan). The BP cuff was tied just tight (neither too loose nor too tight) on the right arm approximately 2 - 2.5 centimeters above from the cubital fossa. It was ensured that the BP cuff was at the level of heart. After 5 minutes of rest in supine position, the "start" button of machine was pressed that automatically inflated and deflated the BP cuff. HR, SBP and DBP were noted from the display screen of the machine. For each subject, HR, SBP and DBP were recorded in same arm thrice, keeping an interval of 5 minutes between the recordings. Mean of the three recordings was considered for each parameter.

Recording and assessment of heart rate variability: After the rest of 5 minutes in supine position, Lead II ECG recordings were done at (25mm/s & voltage at 10mm/mv) for 5 minutes to obtain HRV, using data acquisition system, Polyrite D polygraph, version 2.4 (Recorders and Medicare Systems Private Limited, Chandigarh, India). The ECG signals were converted through a 14-bit A/D converter at a sampling frequency of 256 Hz to PC and were analyzed offline after visual checking of abnormal ECG. All erroneous signals were edited from the data. After expulsion of artifacts and ectopics beats, a stationary R-R series were chosen for analysis. High and low filters were set at 99 and 0.1 Hz respectively. The screen sweep speed was kept at 30 mm/sec. Power spectral density (Fast Fourier Transformation) was computed on 256s tachogram and HRV was assessed using guidelines of Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology [19].

HRV was analyzed with respect to time and frequency domain. The time domain analysis was based on statistical operations of R-R (N-N) intervals. In time domain analysis, the Standard Deviation of Normal-to-Normal intervals (SDNN), Root Mean Squared Standard Deviation (RMSSD), number of Normal-to-Normal interval differences more than 50 milliseconds (NN50) and the Percentage of number of Normal-to-Normal interval differences more than 50 milliseconds (pNN50) were studied.

Among the frequency domain parameters, Low Frequency (LF) power, High Frequency (HF) power, Low Frequency in normalized units (LFnu) and High Frequency in normalized units (HFnu) were included in the study.

Frequency domain was analyzed with respect to Low Frequency (LF) analysis and High Frequency (HF) analysis. Low Frequency spectral powers were determined by integrating the power spectrum between 0.04 and 0.15 Hz and High Frequency spectral powers were determined by integrating the power spectrum between 0.15 and 0.4 Hz respectively.

Statistical analysis of the data: The values of all the parameters were expressed in Mean ± Standard Deviation (SD). Student's unpaired t-test was applied to compare the parameters of the control group and study group. Statistically analysis was done using GraphPad Prism 5 software version 5.03 and P values less than 0.05 was considered to be statistically significant.

RESULTS

Cardiovascular parameters: There was no significant difference in the HR, SBP and DBP between the groups. The results are shown in Table 1.

HRV parameters: The mean values of RMSSD, NN50 and pNN50 were lower in study group but were not statistically significant. The SDNN in control group and study group was 141.90±29.61 and 125.70±24.31 respectively and the difference was highly significant between the groups [Fig.1]. The results are depicted in Table 2.

The mean values of LF power and HF power in the study group was higher and lower respectively in comparison with control group but this difference was statistically insignificant. The LFnu in control group and study group was 43.49±20.05 and 53.41±18.10 respectively. LFnu was more in study group and the difference was statistically significant [Fig.2].The HFnu in control group was 40.12±16.74 and in study group was 33.02±14.03. HFnu was found to be lower in study group than control group and the

difference between the groups was statistically significant [Fig. 3]. The results are given in Table. 3.

Table 1: Comparison of basal cardiovascular parameters in control group and study group.

Parameters	Control group	Study group	't' value	'p' value
HR (bpm)	72.30±10.57	75.05±9.86	1.86	0.0633
SBP (mmHg)	110.70±3.92	112.10±5.81	1.96	0.0506
DBP (mmHg)	71.67±5.88	73.02±4.46	1.82	0.0692

Data is presented as mean ± SD; * p < 0.05 is statistically significant.

HR = Hear Rate, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure.

Table 2: Comparison of basal time domain parameters of HRV in control group and study group.

Parameters	Control group	Study group	't' value	'p' value
SDNN (ms)	141.90±29.61	125.70±24.31	4.23	< 0.0001*
RMSSD (ms)	52.56±21.98	47.17±19.63	1.82	0.069
NN50 (count)	14.02±5.18	12.66±4.62	1.95	0.0524
pNN50 (%)	23.02±8.86	20.71±8.76	1.85	0.0659

Data is presented as mean ± SD; * p < 0.05 is statistically significant.

SDNN = Standard Deviation of Normal-to-Normal intervals, RMSSD = Root Mean Squared Standard Deviation, NN50 = Number of N-N intervals difference more than 50 milliseconds, pNN50 = Percentage of number of N-N intervals difference more than 50 milliseconds.

Table 3: Comparison of basal frequency domain parameters of HRV in control group and study group.

Parameters	Control group	Study group	't' value	'p' value
LF power (%)	74.68±18.12	79.45±17.71	1.87	0.0625
HF power (%)	63.34±22.43	57.73±21.90	1.78	0.0753
LF (n.u.)	43.49±20.05	53.41±18.10	3.67	0.0003*
HF (n.u.)	40.12±16.74	33.02±14.03	3.25	0.0014*

Data is presented as mean ± SD; * p < 0.05 is statistically significant.

LF power = Low Frequency power in percentage, HF power = High Frequency power in percentage, LFnu = Low Frequency in normalized units, HFnu = High Frequency in normalized units.

Fig. 1: SDNN component of HRV in control group and study group.

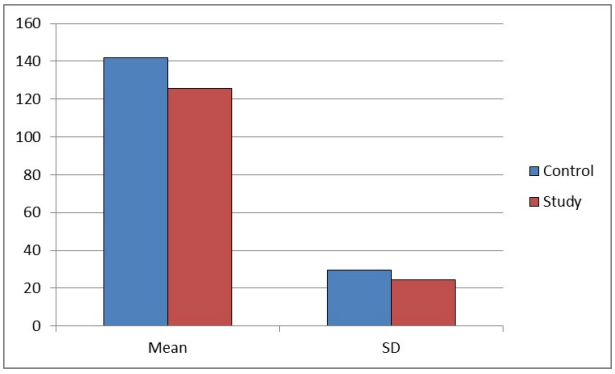


Fig. 2: LFnu component of HRV in control group and study group.

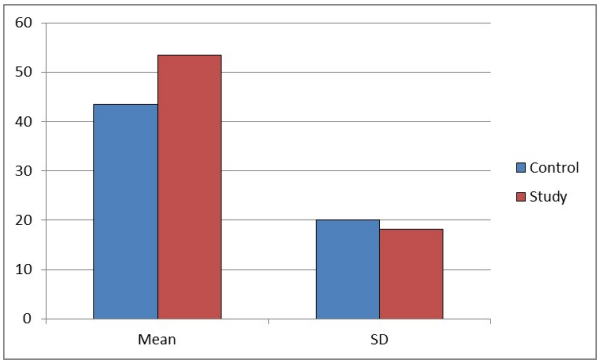
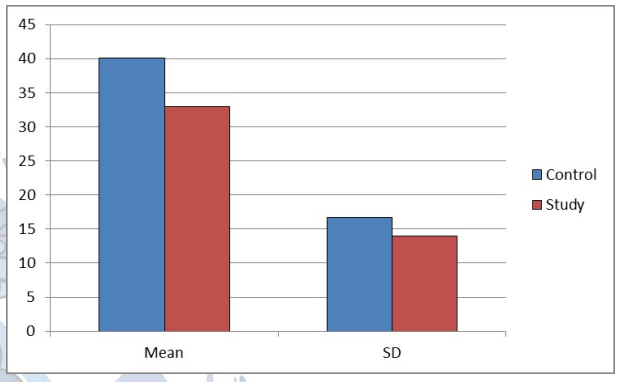


Fig. 3: HFnu component of HRV in control group and study group.



DISCUSSION

It is well known fact that cardiac autonomic imbalance plays an important role in the pathogenesis of hypertension. In this study, our objective was to recognize the cardiac autonomic imbalance in the offsprings of hypertensive parents so that if recognized at the earlier stage, they should aim to improve the cardiac autonomic activity and prevent the risk of development of prehypertension and subsequently hypertension.

We found the basal cardiovascular parameters (HR, SBP and DBP) were higher in the study group i.e. offsprings of hypertensive parents when compared with the control group i.e. offsprings of normotensive parents but they were not significantly higher. This shows that both the groups were normotensive at rest. Similar results have been reported by other investigators [18].

The cardiac autonomic imbalance was evaluated by means of non-invasive analysis of the fluctuations in cardiovascular responses in the form of HRV. It measures the beat-to-beat variations in the successive R-R intervals which occur due to oscillations of the cardiac sympathetic and

parasympathetic supply to the sino-atrial node, the cardiac pacemaker [19, 20].

HRV indices serve as one of the major indicators of the autonomic control on the heart. The time and spectral analysis of HRV is now evolving as a popular tool in diagnosing the autonomic dysfunction in various cardiac [21,22] and non-cardiac disorders [23, 24].

Among the time domain indices, SDNN represents total heart rate variability while RMSSD, NN50 and pNN50% represents parasympathetic activity [19]. The time domain parameters RMSSD, NN50 and pNN50% were lower in the study group but were not statistically significant whereas SDNN was highly statistically lower in the study group when compared to control group.

The LF component of HRV denotes the activity of sympathetic nervous system when expressed in the normalized units and if expressed in power show more sympathetic and less parasympathetic influence [25]. The values of LF power and LFnu were more in study group as compared to control group and the difference in LFnu was statistically significant. The higher values of LF power and LFnu depict enhanced sympathetic activity in the study group compared to control group. It is worth to note that the LF component of HRV may be a strong predictor of future hypertension. Increased in LF power was observed in recent onset hypertension [26].

HF in power or HF in normalized unit directly represents vagal tone. Persons with poor vagal tone are more prone to develop cardiovascular disorders such as hypertension, myocardial infarction, and heart failure. Any reduction in the HF power and/or HFnu indicates decreased vagal tone [27].

We found decrease in both HF power as well as HFnu (statistically significant) in the study group with respect to control group. Low HF power and low HFnu, which was seen in study group, is indicative of poor vagal control in the cardiovascular system.

Our results show that there were decreased time domain measures along with HF power and HFnu while increased LF power and LFnu in the study group with respect to control group. These findings strongly suggest that there was an increased sympathetic activity and decreased parasympathetic activity in the study group when compared to control group indicating presence of cardiac autonomic imbalance in the predisposed group.

Hence through HRV findings, the present study revealed that in spite of normal basal heart rate and blood pressure, level of cardiac autonomic imbalance was more in the offsprings of hypertensive parents than in the offsprings of normotensive parents.

CONCLUSION

We concluded from the present study that there was an increased sympathetic and decreased parasympathetic activity in the offsprings of hypertensive parents than normotensive parents at resting level. Though the baseline heart rate and blood pressure values were normal in both groups, it was by HRV, the cardiac autonomic imbalance could be made out in the offsprings of hypertensive parents. So, recording of HRV becomes mandatory to detect cardiac autonomic imbalance in these genetically predisposed individuals. If detected earlier, preventive measures can be taken to prevent prehypertension and subsequently hypertension in them.

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