Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

Original Research

Comparative study of heart rate variability in offsprings of hypertensive and normotensiveparents

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Received: 27 October, 2023 Accepted:19 November, 2023

Abstract

Background: Hypertension is a risk factor for the development of cardiovascular and cerebro-vascular diseases. Heart rate variability(HRV) provides a window to understand the cardiac autonomic balance. **Aims & Objectives** : To find out any autonomic imbalance by analyzing heart rate variability in off springs of hypertension and non- hypertensive patients and to find out co-relation of HRV with body mass index(BMI),body surface area(BSA)and blood pressure(BP). **Material & Methods** : A cross-sectional (Observational) study was done among 150 students of 1st M.B.B.S (aged 17-25 yrs) who were studying in Govt. Medical College Patiala .Study was divided into two groups consisting of 75 each.Group-1: consist of cases (75) whose parents were hypertensive either father or mother or both being hypertensive.Group-2: Consist of controls(75) whose parents were normotensive. **Results** : High Frequency Millisecond HF(ms^2) caseswere 4.29 $\pm$ 7.73 and in controls were 8.77 ± 17.61 HF(ms^2) was found to be more in controls as compared to study group and the difference between two groups was statistically significant($p<0.05$). The High Frequency Normalized Unit (HFnu) in cases was 30.96$\pm$ 13.30 and in control was 35.26 $\pm$10.42. HFnu was reduced in study group and the difference between two groups was statistically significant ($p <0.05$). Strong negative association of Very Low Frequency VLF (peak HZ) with diastolic blood pressure was seen in cases**.** **Conclusions**: Our study revealed that autonomic dysregulation was present at an early stage in offspring's of hypertensive parents. Hence it is mandatory to inculcate good habits to follow healthy life style to curtail the risk of developing hypertension. Thus HRV is the best tool to detect early changes in the cardio vascular diseases.

Key words: Heart rate variability, hypertension, offspring

Introduction

Hypertension is risk factor for the development of cardiovascular and cerebro-vascular diseases. Cardiovascular diseases remain the top cause of global mortality, with estimated 17.9 million attributed deaths in 2019(32% of global deaths)[1].

Hypertension is a hereditary disease. 25% of the children with one hypertensive parent and 50% of children with two hypertensive parents will eventually become hypertensive. Autonomic abnormality in the form of increased sympathetic tone has been demonstrated in young normotensive offspring of hypertensive patients.[2] HRV has the potential to provide additional valuable insight into physiological and pathological conditions and to enhance risk stratification.[3]

Sympathetic activity tends to increase heart rate and its response is slow (few seconds). Parasympathetic activity, on the other hand, tends to decrease heart rate and mediates faster (0.2-0.6 seconds).[4] The parasympathetic influence on heart rate is modulated by acetylcholine released by the vagus nerve on the sinoatrial node and the sympathetic influence by the release of epinephrine and norepinephrine.[5] The neurovisceral integration model provides a link between prefrontal and subcortical brain structures and autonomic regulation of cardiac activity. Because of these associates, HRV has also been proposed as an index for self-regulatory strength.[6] The HRV is evaluated by two ways: time domain analysis and frequency domain analysis[7] Frequency domain method, whichis also known as power spectral density (PSD), provides the basic information on how power as an expression of variance distributes in the function of frequency.[8] . On a standard electrocardiogram (ECG), the maximum upwards deflection of abnormal QRS complex is at the peak of the R-wave, and the duration between two adjacent R-wave peaks is termed as the R-R interval.The resulting period between adjacent QRS complexes resulting from sinus node depolarizations is termed the N-N (normal-normal) interval. HRV is the measurement of the variability of the N-N intervals.[9]. The present study aims to analyse the indices of Heart Rate Variability in the offsprings of hypertensive and normotensive parents to understand if there is any autonomic imbalance between the two groups . The presented study was conducted to find out any Autonomic imbalance by analyzing heart rate variability (HRV) in offspring of hypertensive and normotensive parents and to find out co-relation of heart rate variability (HRV) with body mass index (BMI), body surface area (BSA), and blood pressure(BP).

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

Materials and Methods

A cross sectional (observational) study was conducted on 150 students (aged 17-25 yrs.) who were studying in Govt. Medical College, Patiala. Study was divided into two groups consisting of 75 each. Group-I: Consist of cases (75) whose parents were hypertensive, either father or mother or both being hypertensive. Group II: Consist of controls (75) whose parents were normotensive.

Exclusive criteria

Subjects with any cardio-vascular/ cardio-respiratory disorders or any disease.

Prerequisites:

- All the subjects were interviewed in accordance with the enclosed proformas.
- Written informed consent was taken from the subjects. Correct procedure of thetest was explained to all the subjects.
- The subject was allowed to relax on a comfortable chair with the subjects' backtowards the recording machine.
- The following anthropometric parameters were measured according to thestandardized techniques.
- Height (in metres)
- Weight (in kg.)
- Body mass index: It was calculated using Quetlet's index.[10]
- BMI = Weight (Kg.) / Height (in m^2)
- Body surface Area : It was calculated using Dubois & Dubois formula
- BSA in $m^2 = 0.007184 \times Weight^{0.425} \times Height\ (m)^{0.725}$

Methods of Recording

Heart rate of each subject was recorded by ECG monitoring, in RR mode (beat to beat) for 5 minutes at rest; in supine position, using 'physiopac hardware' by medicaid.

Method

- Switch on the computer.
- Connect Physiopac Control unit with Computer systems through USB cable.
- Connect Bio potential Junction boxes with channel no. 1 available on the frontpanel of the Physiopac control unit.
- Insert the ECG disc electrodes in the sockets of Bio-potential junction boxes.
- Click on the icon of Physiopac available on the computer screen.
- Fill user ID and password and then click at OK.
- To make new subject entry click at ADD NEW.
- Fill the details of the subject and click at SAVE button to save the subject data.
- Click at NEW TEST and select the ECG parameter on channel 1.

Placement of electrodes

- Place the ECG electrodes on the subject. Place the electrodes on RA (right arm), LA (left arm), LL (left leg), and RL (right leg).
- After placement of electrodes and selection of parameter click at OK.
- Click at Start/Stop button the data will start to run on the screen. Let the graph besmooth and artifacts free.
- After receiving data in good and accurate waveform click at Recording button tostart the recording of data.
- After recording sufficient data, stop the running data and exit.
- To review data click at view test.

HRV Analysis

- Click at transform button, select HRV.
- Fill the required time and click at-OK button to achieve the HRV data for thatparticular time.
- After completing the test click on stop button to stop the test.
- Click on the File option and select Save option and save the file at your desiredlocation.
- Click at close button to exit the test.

Data collected was statistically analysed using student t test for equal variance, for various parameters. Pearson's co-relation coefficient was used to find co- relation of HRV with BMI, BSA and BP.

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Results

Table -1 Distribution of the Anthropometric Data in the Cases & Controls

Variables	Cases (n_1=75) Mean + SD	Controls(n_2 = 75) Mean + SD	t value	P value
Age (in years)	18.72 ± 0.92	18.62 ± 0.73	0.686	0.494**
Height (in cms.)	162.99 ± 8.46	164.99 ± 9.90	1.349	0.179**
Weight (in Kgs.)	56.93 ± 9.69	58.91 ± 12.07	1.110	0.269 **
Body Mass Index(in Kg/ m^2)	21.28 ± 3.06	21.48 ± 3.02	0.410	0.682 **
BSA (m^2)	1.59 ± 0.16	1.63 ± 0.18	1.573	0.118**
Systolic BloodPressure	11.792 ± 10.71	118.49 ± 8.37	0.365	0.716 **
Diastolic Blood Pressure (mm of Hg)	80.22 ± 6.44	77.92 ± 7.58	2.008	0.047*

- Significant: p< 0.05, ** Not Significant : p > 0.05

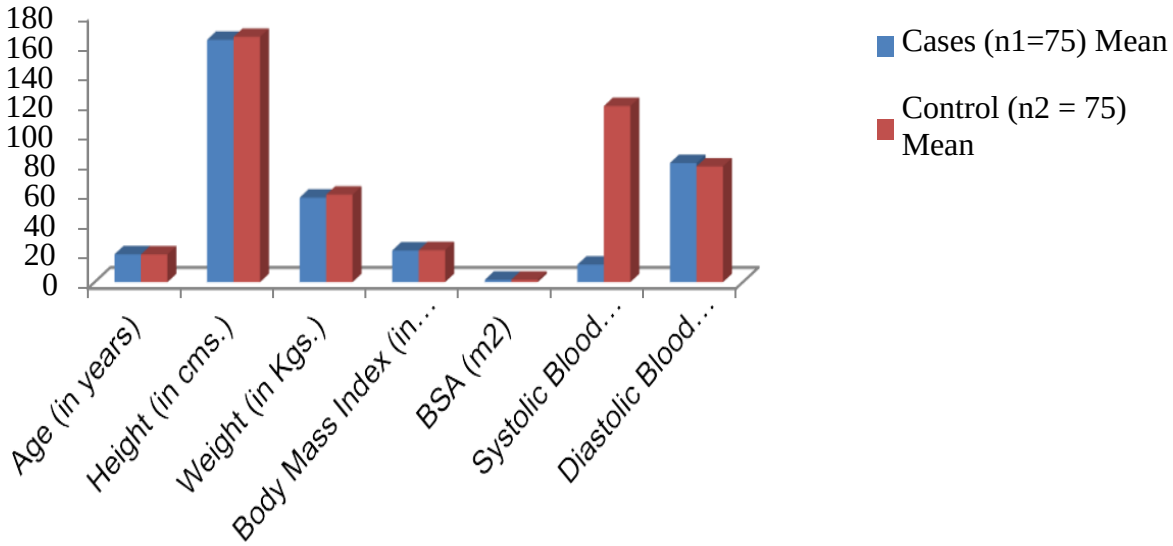

Fig-1: Distribution of the anthropometric data in the cases & Controls

Table 1: shows that different variables i.e. age, height, weight, body mass index, body surface area and blood pressure of cases and controls. The values of all the parameters were expressed in mean ± SD and they were compared by applying unpaired student t test. There was no significant difference in the age, height, weight, BMI and BSA between the two groups. There was no significant difference in the systolic blood pressure (SBP) between the two groups. Diastolic blood pressure when in study group was compared with controls it showed significant difference ($p < 0.05$).

Table 2 shows the comparison of Time Domain Analysis i.e. Mean, RR, STD (SDNN), Mean HR, RMSSD, NN50 and pNN50. The mean RR in the study group was

0.73 ± 0.10 and in the controls was 0.75 ± 0.11, the difference between the two was not statistically significant.The SDNN in cases was 0.31 ± 0.01 and in Controls was 0.04 ± 0.03. Though it was more in cases but was not statistically significant. The Mean HR was move in the Study group i.e. 82.46 ± 9.78 as compare to controls

i.e. 79.74 ± 8.37, the difference between the two groups was statistically insignificant. RMSSD in cases was 26.48 ± 14.74 and in control was 29.51 ± 22.10. Though it was reduced in cases, it was not statistically significant. The NN50 in cases was 9.42 ± 6.60 and in controls was 10.21 ± 7.20. The difference between the two groups was not statistically significant. Similarly pNN50 in cases was 6.57 + 4.57 and in controls was 7.13 ± 4.95 and the difference between the two groups was not statistically significant. Table 3 shows the comparison of Frequency Domain Analysis i.e. VLF Peak, LF Peak, HF peak, VLF Power, LF Power, HF Power, VLF Power %, LF Power %, HF Power %, LF/HF ratio, LF Power N.u and HF Power nu. The LF in the study group was increased Controls was 8.77 ± 17.61. HF (ms^2) was found to be more control as compare to study group and the difference between two groups was statistically significant. ($p < 0.05$) LF nu in cases was 69.63 ± 13.30 and in control was 69.59 ± 11.22. LF nu was found to be higher in cases as compare to controls and the difference between

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

the two groups was statistically insignificant.
The HFnu in cases was 30.96 ± 13.30 and in controls was 35.26 ± 10.42. HFnu was reduced in study group and the difference between two groups was statistically significant. ($p<0.05$) i.e. 15.37 ± 47.02 as compared to controls i.e. 11.74 ± 21.83. The difference between thetwo groups was not statistically significant. HF (ms^2) cases was 4.29 ± 7.73 and in

Table 2: Comparison of Time Domain Parameters of HRV among Cases andControl Subjects

Variables	Cases (n_1=75) Mean + SD	Controls(n_2 = 75) Mean + SD	t value	P value
Mean RR (Sec)	0.73 ± 0.10	0.75 ± 0.11	0.931	0.353**
STD/SDNN (Sec)	0.31 ± 0.01	0.04 ± 0.03	1.216	0.226**
Mean HR (per min.)	82.46 ± 9.78	79.74 ± 8.37	0.119	0.690 **
STD per minute	4.72 ± 3.50	5.11 ± 4.22	0.365	0.537 **
RMSSD (MS)	26.48 ± 14.74	29.51 ± 22.10	0.988	0.325**
NN50 (Count)	9.42 ± 6.60	10.21 ± 7.20	0.697	0.487 **
pNN50	6.57 ± 4.57	7.13 ± 4.95	0.724	0.470**

* Significant: p< 0.05, ** Not Significant : p > 0.05

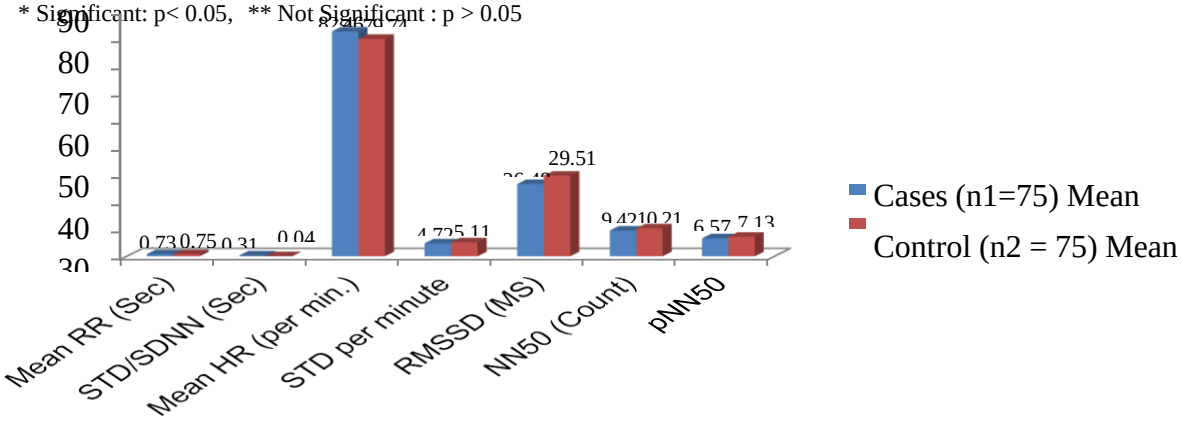

Fig-2: Comparison of time domain parameters of HRV among cases and control subjects

Table 3: Comparison of Frequency Domain Parameters of HRV among Cases andControl Subjects

Variables	Cases (n_1=75) Mean + SD	Controls(n_2 = 75) Mean + SD	t value	P value
VLF (Peak HZ)	0.029 ± 0.009	0.030 ± 0.016	0.495	0.622**
LF (Peak HZ)	0.80 ± 0.072	0.093 ± 0.112	0.846	0.399**
HF (Peak HZ)	0.176 ± 0.021	0.175 ± 0.024	0.375	0.708 **
VLF(Power ms^2)	4.66 ± 8.81	5.96 ± 11.10	0.790	0.431 **
LF (Power ms^2)	15.37 ± 47.02	11.74 ± 21.63	0.607	0.545**
HF (Power ms^2)	4.29 ± 7.73	8.77 ± 17.61	-2.016	0.046 *
VLF (Power %)	23.55 ± 12.50	25.91 ± 13.62	1.107	0.270**
LF (Power %)	52.66 ± 13.17	51.25 ± 11.53	0.694	0.89**
HF (Power %)	23.81 ± 11.50	22.82 ± 10.36	0.550	0.583**
LF/HF Ratio	2.87 ± 1.85	2.77 ± 1.47	0.355	0.723**
LF (Power n.u.)	69.63 ± 13.30	69.59 ± 11.22	0.279	0.787**
HF (Power n.u.)	30.26 ± 13.30	35.26 ± 10.42	-2.202	0.029*

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

Significant: p< 0.05, ** Not Significant : p > 0.05

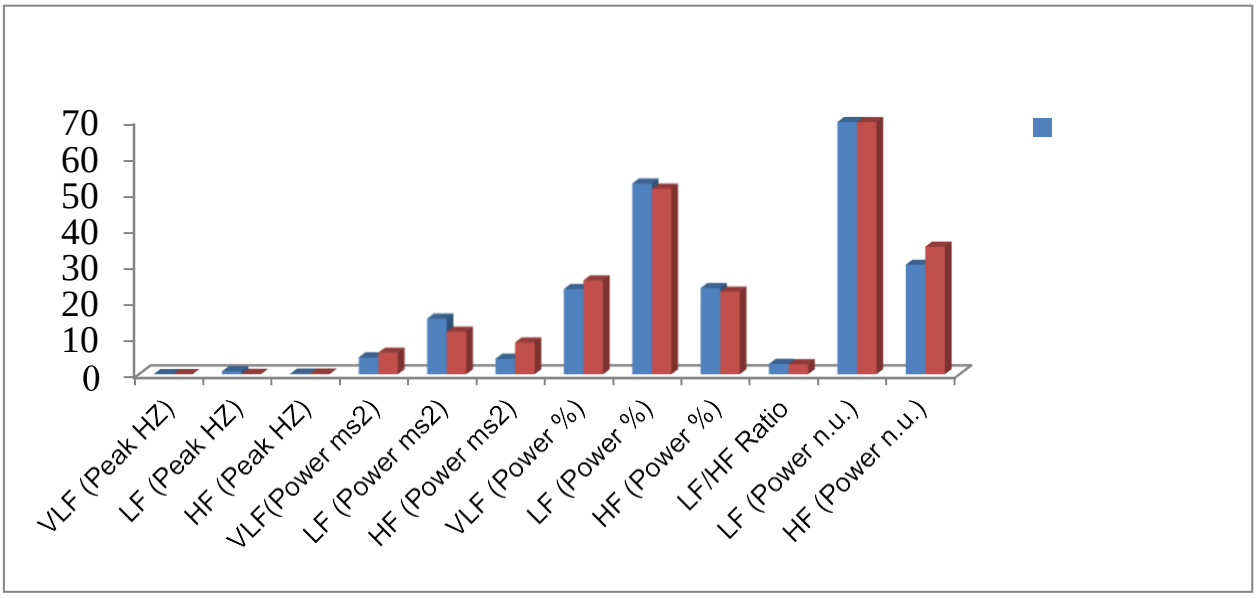

Fig-3: Comparison of frequency domain parameters of HRV among cases andcontrol subjects.

TABLE-4: Co-relation of Time Domain Indices of HRV with BMI among cases andcontrol subjects

Variables	Cases (n_1=75)		Controls (n_2=75)	
	r value	P value	r value	P value
Mean RR (Sec)	-0.112	0.338**	-0.028	0.814**
STD/SDNN (Sec)	0.077	0.512**	0.040	0.731**
Mean HR (per min.)	0.096	0.415**	-0.040	0.734**
STD per minute	0.247	0.032*	-0.057	0.628**
RMSSD (MS)	0.059	0.613**	0.038	0.745**
NN50 (Count)	-0.084	0.476**	0.012	0.917**
pNN50	0.074	0.528**	0.014	0.904**

* Significant: p< 0.05, ** Not Significant : p > 0.05

Table 4 shows the co-relation analysis of Time Domain Parameters of HRV with BMI i.e.Mean RR (Sec)STD/SDNN (Sec)Mean HR (per min.) STD per minute RMSSD (MS) NN50 (Count) pNN50. Although there was strong negative co-relation of Mean RR with BMI among cases and controls, yet it was found to be statistically non-significant. (r= -0.112, p>0.05 and r=-0.028, p>0.05 respectively) STD/ SDNN showed positive co-relation with BMI both in cases and control (r= -0.077, p>0.05 and r=-0.040, p>0.05 respectively). It was statistically insignificant. Similarly Mean HR also showed weak positive association with BMI in cases and strong negative association with BMI incontrols (r= 0.096, p>0.05 and r=-0.040, p>0.05 respectively). There was significant positive co-relation of STD (per minute) with BMI in cases and strong negative association in controls (i.e. r= 0.247, p>0.05 and r=-0.057, p>0.05 respectively). The co-relation of BMI with cases was found to be statistically significant p<0.05. RMSSD showed weak positive association with BMI, both in cases and controls (r=0.059, p>0.05 and r=-0.038, p>0.05 respectively). The co-relation of BMI with cases and controls was statistically insignificant. NN50 showed strong negative association of BMI in cases and weak positive association in controls (r= -0.084, p>0.05 and r=0.012, p>0.05 respectively). It wasstatistically insignificant. pNN50 also showed positive co-relation with BMI in casesas well in controls (r= -0.074, p>0.05 and r=0.014, p>0.05 respectively). The co- relation of BMI with HRV indices pNN50 was statistically insignificant.

Discussion

In our study we found that there was no significant difference in thesystolic blood pressure between the study group and the control. However, diastolic blood pressure (80.22 $\pm$ 6.44) was higher in study group as compared to control (i.e. 77.92 $\pm$ 7.58) and the difference between the two groups was statistically significant ($p < 0.05$). Julius et al (1991) studies had shown that those with

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

parental history of hypertension, their off springs show higher resting diastolic blood pressure probably due to hyperactive sympathetic nervous system (SNS). As a result increased SNS activity cause an increase in heart rate, peripheral vasoconstriction resulting in the increased peripheral vascular resistance with rise in the systemic blood pressure. In the present study Comparison of Time Domain Parameters of HRV among Cases and the Control subjects was.shown. The mean RR was lower in study group (0.73 ± 0.10) as compared to control (0.75 ± 0.11) and it was not statistically significant. In our study mean HR was more (i.e. 82.46 ± 9.78) in cases as compared to controls (i.e. 79.74 ± 8.37) but we did not find a significant difference between the two groups. This may be due to younger age group and the BMI was within normal limits and so almost all of them had a normal resting heart rate. Similar findings were also recorded by Muralikrishnan et al and Pal G.K. etal (2011)[11,12], Preeti et al (2013)[13] and Chinagudi Surekharani et al. (2013)[2]. In this study though there was decrease SDNN (0.03 ± 0.01) in study group as compared to control (0.04 ± 0.03) it was not statistically significant ($p > 0.05$). A lower SDNN indicates diminished baroreflex modulations of RR intervals and also represents the long term vagal modulation of cardiac functions. There was decreased RMSSD (26.48 ± 14.74) in the study group when compared with the control groups (29.51 ± 22.10) and were not statistically significant ($p > 0.05$). RMSSD reflects Vagal modulation of heart rate and therefore RMSSD is considered as an important short term indicator of parasympathetic drive.[14] In our study although NN50 and pNN50 were decreased in the study group as compared to control group yet there was no statistically significant between the two groups ($p > 0.05$). The results of our study are similar to Mohamed Faisal Lufti and Mohamed Yosif Sukkar (2011)[15], Chinagudi Surekharanietal (2013)[2] and Patel A Parbatet al (2015)[16] In our study we found the co-relation of Time Domain Indices of Heart Rate Variability (HRV) with BMI was present. STD/ SDNN showed positive co-relation with BMI both in cases and control ($r= -0.077$, $p>0.05$ and $r=-0.040$, $p>0.05$ respectively). It was statistically insignificant. Similarly Mean HR also showed weak positive association with BMI in cases and strong negative association with BMI in controls ($r= 0.096$, $p>0.05$ and $r=-0.040$, $p>0.05$ respectively). The co-relation of BMI with cases was found to be statistically significant $p<0.05$. .There was strong negative association of Mean RR with systolic & diastolic Blood pressure among cases and controls ($r= -0.121,-0.088; p>0.05$ and $r=-0.118$, -0.180; $p>0.05$ respectively). The co-relation was statistically insignificant. Similar findings were also recorded by B. Gwen Windham etal (2012)[17]; Gopal Krushna Pal etal (2012)[18]; Gui-Ling Xie etal (2013)[19] and Marijana Tadic etal (2015)[20]. Comparison of frequency Domain Parameters of HRV among cases and controls was seen. . Our study showed that there was increased LFnu (69.63 ± 13.30) and decreased HFnu (30.26 ± 13.30) and increased LF/HF ratio (i.e. 2.87 ± 1.85) along with decreased SDNN (i.e. 0.03 ± 0.01) in the study group i.e. normtensive offsprings of hypertensive parents when compared with controls i.e. normotensive offsprings of normotensive parents. These findings indicate that there is increased sympathetic activity and decreased parasympathetic activity in the study group when compared with the control group. Similar results have been reported by other investigated like Pal G.K etal (2011)[11]; Muralikrishnan etal (2011)[12] and Chinagudi Surekharanietal (2013)[2]. In the present study LF power was increased compared to control group even at supine rest. LF expressed in power includes more sympathetic and less parasympathetic influence.[14] LF reflects the sympathetic activity when represented in the normalized by some others workers. Further LF component of power spectral analysis is predicative of the development of hypertension in men in their later ages. Framingham study has shown adiposity to be a strong predictor of hypertension in men women[14]. It is worth to note that LF component of HRV to be a strong predictor of future hypertension though BMI, a measure of obesity. Increased in LF power was observed in the recent onset hypertension. [21] In our study there was decrease in VLF, and HF (ms^2) in the study group as compared to control group and the difference between two groups was not significant. Our results which agree with those earlier studies indicating that HF power is significantly diminished in the study group during supine rest. HF in power is the direct representation of vagal tone. Vagal tone is an important determinant of cardiovascular health. Vagal tone of an individual has insightful influence on the heart rate, cardiac output and blood pressure. Persons with poor vagal tone are more prone to develop cardiovascular diseases such as myocardial infarction, hypertension and heart failure. There was weak positive association of VLF (Peak HZ) with systolic blood pressure and strong negative association of VLF (Peak HZ) with Diastolic blood pressure in cases ($r = 0.005$; $p > 0.05$ and $r= -0.243$; $p < 0.05$ respectively). The co-relation with Diastolic B.P. was found to be statistically significant $p < 0.05$. LF and HF Ratio showed weak positive association of systolic blood pressure and strong negative association of Diastolic Blood Pressure in cases. LF (n.u.) showed strong negative association of systolic and Diastolic blood pressure in controls. The co-relation of systolic blood pressure was found to the statistically significant $p<0.05$ and co-relation of diastolic blood pressure was found to be statistically insignificant. Similar findings were also recorded by B. Gwen Windham et al (2012)[17]; Gopal Krushna Pal etal (2012)[18]; Gui-Ling Xie et al (2013)[19] and Marijana et al (2015)[20].

Conclusion

Our study revealed that autonomic dysregulation was present at an early stage in offspring of hypertensive parents. Hence it is mandatory to inculcate good habits to follow healthy life style to curtail the risk of developing hypertension. Thus HRV is the best tool to detect early changes in the cardio vascular diseases.

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ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

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