

Original Research Article

Assessment of Cardiac Autonomic Activity Before and After Isotonic Exercise Training (Treadmill Ergometer) in the Offsprings of Hypertensive Parents

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Abstract: It is accepted that genetics and the environmental factors play an important role in the genesis of hypertension. Parental history of hypertension increases the risk of developing hypertension at younger age. Isotonic exercise is an exercise that improves oxygen consumption by the body. Heart rate variability is a valuable research tool to study and investigate the cardiac autonomic activity. The present study was planned to assess the effect of isotonic exercise training (treadmill ergometer) on cardiac autonomic activity in the normotensive offsprings of hypertensive parents. A total of 50 normotensive subjects of age group between 18 to 26 years whose parents, either father or mother or both are hypertensive, were selected for the study. Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and HRV parameters were recorded before exercise (baseline) and after the completion of isotonic exercise training (treadmill ergometer) schedule of four successive days a week for three months according to the modified Bruce protocol. After exercise training, we observed a significant reduction in Heart Rate (beats per min.) and Systolic Blood Pressure (mmHg) where as a highly significant increase in High Frequency in power percentage as well as significant increase in High Frequency in normalized units in comparison with their basal parameters. Our results suggest that even a short duration of regular isotonic exercise training (treadmill ergometer) for four successive days a week for three months can improve vagal tone.

Keywords: Hypertension, Isotonic exercise, HRV

INTRODUCTION:

Hypertension is a multifaceted progressive disease process spanning several decades of life. 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 levels of 120-139 mmHg and diastolic blood pressure levels of 80-89 mmHg. The cut off values for normal blood pressure has been revised to 120/80mmHg [1]. Primary hypertension is widely known as "essential hypertension", blood pressure is raised without any underlying disease. Risk factors for primary hypertension include heredity, obesity, mental stress and smoking [2]. The likelihood of acquiring primary hypertension in the offsprings of hypertensive parent has been estimated higher especially if both the parents are hypertensive when compared to that of normotensive individuals [3-5]. Autonomic abnormality in the form of increased sympathetic tone has been demonstrated in young normotensive offsprings of hypertensive parents. The increased sympathetic and decreased parasympathetic activities in young adults

alter sympathovagal balance, which could be the major mechanism in the causation of prehypertension [6-8]. Several studies have assessed sympathovagal imbalance in hypertensive patients [9-11] and sustained sympathetic over activity has been reported as among the primary mechanisms for genesis of primary hypertension [12-15].

Lack of regular physical exercise is a common problem in the present scenario which affects the cardiac autonomic activity. Exercise may be isotonic or isometric. A well designed 12 weeks isotonic exercise training programme decreases resting heart rate in both younger and older adults [16]. A recent study suggested that isotonic exercise (walking) reduces heart rate and blood pressure in hypertensive individuals [17]. At present, HRV investigation has superseded classic test for autonomic functions because it quantifies sympathetic and parasympathetic activity [18-20]. Therefore, in the present study, we have analyzed the HRV indices to assess cardiac autonomic activity

before and after isotonic exercise training (treadmill ergometer) in the offsprings of hypertensive parents.

MATERIAL AND METHODS:

Before initiation of the study, approval was obtained from the ethical committee of Swami Vivekananda Subharti University, Meerut (U.P.). The students studying at undergraduate level in Swami Vivekananda Subharti University, Meerut were selected as subjects and entire study was conducted in the department of Physiology at Subharti Medical College, Meerut (U.P.). A total of 50 normotensive male subjects in the age group of 18 to 26 years were selected for the present study 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 antihypertensive therapy. A detailed history and clinical examination was done to exclude subjects satisfying exclusion criteria. Weight in kilograms and height in meters were measured and BMI ($22.5 \pm 2.4 \text{ Kg/m}^2$) was calculated. The subjects were asked to report to the research laboratory of the department in the morning between 9 - 11 A.M. for the study, after having light breakfast without tea or coffee 2 hours prior to testing. Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and HRV parameters were recorded on day 1 for baseline. The subjects were underwent an isotonic exercise training (treadmill ergometer) for 4 successive days a week for 3 months according to the modified Bruce protocol. The entire duration of isotonic exercise training was of 20 minutes i.e. 2 minutes warm up in the form of stretching followed by treadmill for 15 minutes and ended with 3 minutes cool down exercise. All the above mentioned parameters were also recorded on the next day of completion of exercise training schedule between 9 - 11 A.M. to analyze the effect of isotonic exercise training (treadmill ergometer) on cardiac autonomic tone in the offsprings of hypertensive parents.

Recording of heart rate, blood pressure and HRV parameters:

After 5 minutes of rest in supine position, the heart rate and blood pressure were measured in the right arm by automatic blood pressure measuring machine (Accusure TD 3127, Taiwan). For each subject, HR, SBP and DBP were recorded in same arm three times at an interval of 5 minutes between the recordings and for each parameter, the mean of three recordings was considered. After the rest of 5 minutes in supine position, the 5 minutes ECG was recorded in lead II using RMS digital polygraph, polyrite AD version 3.0.7 India, for short term HRV analysis.

Statistical analysis:

Data was presented as Mean \pm Standard Deviation (SD). Mean and standard deviation of the observation for all the parameters were calculated and comparisons were done by applying student's paired t-test. P value < 0.05 was considered significant. Frequency domain analyzed with respect to Low Frequency (LF) and High Frequency (HF) analysis. Low Frequency and High Frequency spectral powers were determined by integrating the power spectrum between 0.04 and 0.15 Hz and between 0.15 and 0.4 Hz respectively.

RESULTS:

Measures of HR, SBP, DBP and HRV parameters before and after isotonic exercise training are illustrated along with Mean \pm SD. Table 1 shows HR, SBP, DBP and frequency domain of HRV parameters before and after the completion of isotonic exercise training (treadmill ergometer) schedule. After exercise training, significantly lower values of HR and SBP were observed in our subjects. The mean values of LF, LFnu and LF: HF ratio was also decreased but the difference was not statistically significant. On the other hand mean value of HF showed a highly significant increase from pre-exercise to post-exercise value. The mean value of HFnu was also increased significantly after exercise training when compared to its mean value observed at basal level but the value was not statistically high as compared to post-exercise mean value of HF.

Table 1: Comparison of pre and post-exercise training parameters

Variables	Before exercise training (Mean \pm SD)	After exercise training (Mean \pm SD)	't' value	'p' value
Heart Rate, HR (bpm)	79.62 \pm 4.96	72.96 \pm 4.03	7.40	0.0009*
Systolic Blood Pressure, SBP (mmHg)	115.82 \pm 5.84	111.74 \pm 4.52	3.92	0.0003*
Diastolic Blood Pressure, DBP (mmHg)	74.44 \pm 5.07	72.96 \pm 4.88	1.49	0.14
Low Frequency, LF (%)	46.18 \pm 10.45	44.84 \pm 9.71	0.66	0.50
High Frequency, HF (%)	31.92 \pm 6.12	37.68 \pm 5.93	4.8	0.00001*
Low Frequency in normalized units, LFnu	56.22 \pm 7.78	53.76 \pm 7.59	0.93	0.35
High Frequency in normalized units, HFnu	21.94 \pm 5.75	27.18 \pm 5.53	4.67	0.00002*
LF:HF ratio	1.44 \pm 1.70	1.19 \pm 1.63	0.80	0.42

* p < 0.05 was considered significant.

DISCUSSION:

The present study was conducted to evaluate the effect of short duration of isotonic exercise training on the heart rate, blood pressure and Heart Rate Variability in the normotensive offsprings of hypertensive parents. We found that basal cardiovascular parameters (HR, SBP and DBP) were higher as compared to after the completion of isotonic exercise training schedule in our subjects. Our results support various studies which showed that the offsprings with parental history of hypertension have higher basal cardiovascular parameters probably due to hyperactive sympathetic nervous system. As a result, increased activity of sympathetic nervous system causes an increase in the heart rate, peripheral vasoconstriction resulting in the increased peripheral vascular resistance with rise in systemic blood pressure [18]. HRV is a physiological phenomenon that occurs mainly due to sinus arrhythmia. In sinus arrhythmia, during inspiration impulse in the vagii from the stretch receptors in the lungs inhibits the cardiac inhibitory area in the medulla oblongata and the heart rate rises [19]. HRV reflects the balance between sympathetic and parasympathetic branches of autonomic nervous system [20-21]. The various parameters of HRV that were evaluated in the present study were namely, Low Frequency in power percentage (LF), High Frequency

in power percentage (HF), Low Frequency in normalized units (LFnu), High Frequency in normalized units (HFnu) and ratio of Low Frequency in power percentage (LF) to High Frequency in power percentage (HF). We observed high values of LF, LFnu and LF:HF ratio and low values of HF as well as HFnu in the normotensive offsprings of hypertensive individuals at resting level. Similar results have been reported by other investigator [22]. Isotonic (Dynamic) exercise, muscular contraction resulting in movement, primarily subjects the left ventricle to volume load and the cardiovascular response was commensurate with the intensity and severity of the exercise [23]. Stair climbing, an example of isotonic exercise is a good physiological maneuver to evaluate the sensitivity and specificity of the cardiovascular system to the exercise [24]. Treadmill ergometer is an effective source of isotonic exercise as it leads to high oxygen consumption in muscle, which involved during exercise. The use of this machine presents a number of advantages as it is possible to adjust the speed and grade of walking according to the ability of the subjects [25]. Our results showed that there was a significant decline in heart rate and systolic blood pressure while diastolic blood pressure was insignificantly reduced in our subjects after isotonic exercise training.

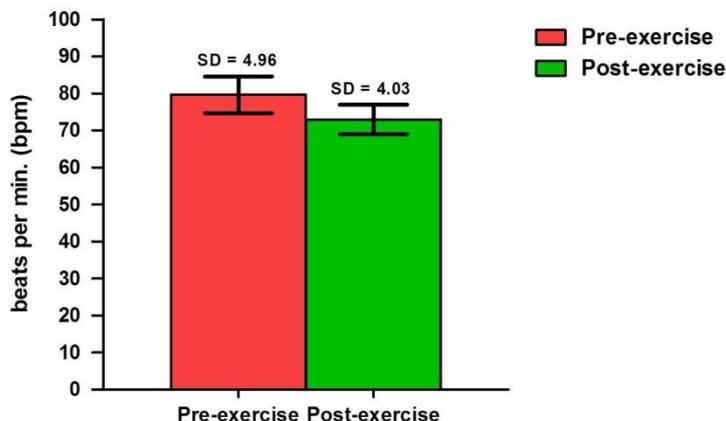


Fig-1: Effect of Isotonic Exercise Training on Heart Rate

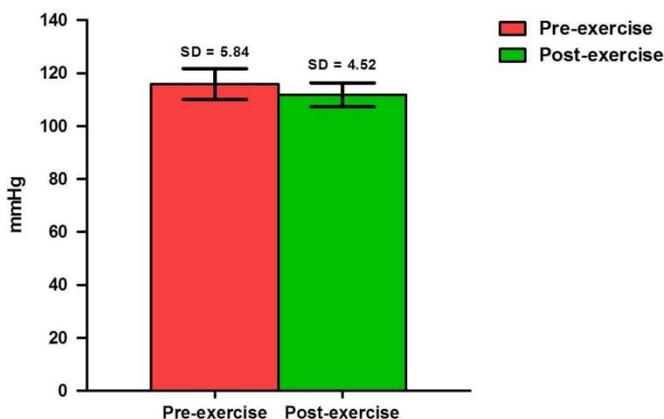


Fig-2: Effect of Isotonic Exercise Training on Systolic Blood Pressure

LF reflects the sympathetic activity when represented in the normalized units and if expressed in power showed more sympathetic and less parasympathetic influence [26]. Increase in LF power was observed in the recent onset of hypertension [27]. The mean value of LF and LFnu was found to be decreased after the completion of isotonic exercise training as compared to the value observed before exercise training but was not statistically significant. Decrease in LF and LFnu was also observed in cardiovascular autonomic response to whole body isotonic exercise in healthy young adult males with parental history of hypertension [28]. The sympathovagal balance is assessed by the LF: HF ratio and increased LF: HF ratio reflects increased sympathetic activity, while decreased LF: HF ratio indicates decreased sympathetic activity [29]. We found decrease in LF: HF ratio in our subjects after post-

exercise training when compared to their pre-exercise value. Larger sample size might show some significant difference in LF, LFnu and LF: HF ratio between pre-exercise and post-exercise training parameters. Either HF in power or HF in the normalized units 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 hypertension, myocardial infarction and heart failure. Any reduction in the HF power and/or HFnu indicates decreased vagal tone [29]. In the present study, the mean value of HF was highly increased to a significant value from pre-exercise (31.92 ± 6.12) to post-exercise training (37.68 ± 5.93). The HFnu was also increased significantly after exercise training.

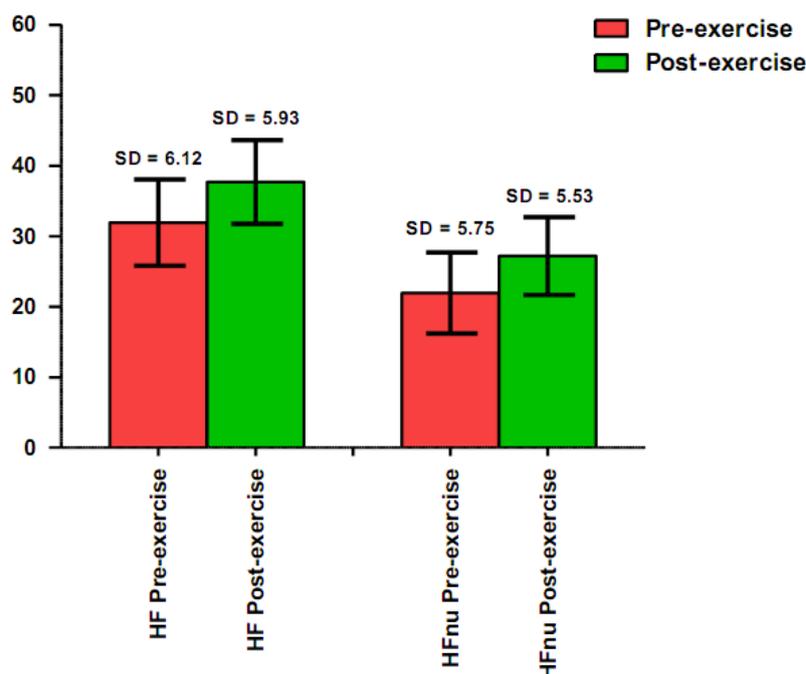


Fig-3: Effect of Isotonic Exercise Training on HF and HFnu of HRV indices

Increased HF, HFnu and decreased LF, LFnu and LF: HF ratio variables of HRV indices after completion of isotonic exercise training (treadmill ergometer) in the normotensive offsprings of hypertensive parents indicate improvement in the vagal tone.

Exclusion criteria:

Subjects with any clinical sign 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, smokers and alcoholic were excluded from the present study.

CONCLUSION:

Our study supports that a short duration of regular isotonic exercise training (treadmill ergometer) for four successive days a week for 3 months can improve vagal tone and prevents the development of hypertension in the normotensive offsprings of hypertensive individuals as they are prone to early onset of primary hypertension.

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