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Original Research Article

Effect of exercise on heart rate recovery index in normotensive offspring with family history of hypertension

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ABSTRACT

Background: The relationship between autonomic system and cardiovascular mortality is significant and this study can be used to study the hereditary risk that an individual carries to develop any autonomic dysfunction and its effect on cardiovascular status. In this study, we aimed to investigate the heart rate recovery index and prevalence of cardiovascular risks in subjects with hypertensive parents.
Methods: A total of 30 subjects and 30 healthy controls were recruited in the study. Their anthropometrical and cardiovascular parameters were recorded. Heart rate, blood pressure, weight and height of subjects were measured and BMI calculated. After 3 min step test heart rate will be measured in 1, 2, 3 and 5 minute and heart rate recovery index calculated by subtracting maximum heart rate achieved during exercise by heart rate measured in 1,2,3 and 5 minute. The heart rate recovery index (HRRI) is calculated by extracting the maximum heart rate during treadmill stress testing from the heart rate.
Results: The 1st minute HRRI was not significantly different in the groups (43.87±11.54 and 43.00±18.77 respectively, p=0.88). Likewise, the 2nd minute HRRI (50.07±10.38and49.07±16.32 respectively, p=0.843), 3rd minute HRRI (53.33±12.72 and 53.60±17.56 respectively, p=0.962), 4th minute HRRI (55.07±13.25 and 54.60±14.73 respectively, p= 0.928) and 5th minute HRRI (56.33±14.58 and 54.87±14.93 respectively, p=0.788) were also not significantly different.
Conclusions: Findings of this study suggest that in the absence high arterial pressure and other comorbidities, a family history of hypertension is not accompanied by dysfunction of autonomic system.

Keywords: Exercise, Heart rate, Hypertension

INTRODUCTION

Elevated blood pressure has been known to be a huge risk factor for cardiovascular disease later in life and leads to increased morbidity and mortality.[1] Evidence from studies suggests that autonomic nervous system plays a crucial role in the development of hypertension and autonomic dysfunction underlies the initiation and maintenance of hypertension.[2] Although the association of smoking and hypertension with increased cardiovascular morbidity and mortality is a generally accepted fact, the mechanisms by which these factors are linked to cardiovascular damage are not yet clarified.[3]

Sympathetic activity increases during exercise but decreases in the resting period, whereas parasympathetic activity is suppressed during exercise but activated in the resting period, leading to a decrease in the heart rate[4,5] In

various studies, an abnormal HRRI has been defined as a decrease by less than 12 beats per minute in the 1st-minute heart rate in the resting period, and this is an independent predictor for both cardiovascular and all-cause mortality.[6,7]

A cross sectional study has shown that haemodynamic, metabolic and neuro-humoral abnormalities in young normotensive women at high familial risk for hypertension, women with two hypertensive parents showed higher exercise and recovery diastolic blood pressure than women with both normotensive parents. haemodynamic, metabolic and hormonal abnormalities were presented in nonhypertensive young women offspring of hypertensive parents before any increase in blood pressure.[8] Hemodynamic and metabolic profile in offspring of malignant hypertensive parents in 24 hour ambulatory monitoring the offspring of malignant hypertensive parents presented higher 24 hour blood pressure and heart rate, higher blood pressure during the night, and higher heart rate variability during the day compared with those of the offspring of normotensive parents group.[9]

Early 24-hour blood pressure elevation in normotensive subjects with parental hypertension normotensive subjects whose parents are both hypertensive had higher prolonged resting and 24hour blood pressure than the normotensive subjects whose parents are not hypertensive; the difference was always significant for systolic blood pressure. The blood pressure values of the normotensive subjects with one hypertensive parent tended to be between those of the other two groups.[10] Increased response of blood pressure to rest and handgrip in subjects with essential hypertension the decrease in blood pressure from casual to rest were significantly greater in men with essential hypertension than in healthy normotensive men.

Also, the increase in systolic blood pressure in the handgrip exercise is significantly greater in men with essential hypertension than in healthy normotensive men.[11] Sympathoneural responses to the cold pressor test in individuals with essential hypertension and in those genetically predisposed to hypertension the normotensive subjects with a family history of hypertension displayed slightly less increase in systolic blood pressure while muscle sympathetic nerve activity was greater than that of normotensive subjects with no family history of hypertension during cold pressure test.[12]

Increased response to physical and mental stress in men with hypertensive parent's absolute blood pressure levels were significantly higher during isometric handgrip exercise just before exhaustion in subjects with positive family history of hypertension than subjects with negative family history of hypertension. During the mental stress test, the blood pressure response was significantly greater in subjects with positive family history of hypertension.[13]

Iwase et al, studied abnormal baroreflex control of heart rate in normotensive young subjects with a family history of essential hypertension. They found that Baroreflex sensitivity was significantly lower in normotensive subjects with hypertensive relatives than in normotensive subjects with no family history of hypertension.[14]

Influence of gender and family history of hypertension on autonomic control of heart rate, diastolic function and brain natriuretic peptide was studied and it was found that the group with a family history of hypertension had higher systolic pressure, heart rate while lower heart rate variability, diastolic function and brain natriuretic peptide than group without a family history of hypertension.[15]

Sympathetic reactivity in young women with a family history of hypertension was found to be increased blood pressure in women with family history of hypertension during cold pressure test and during the last minute of hand grip test. Similarly, the increase in MSNA was greater in women with family history of hypertension during both hand grip and cold pressure test than in women with no family history of hypertension.[16]

The rise in heart rate during exercise is considered to be due to the combination of parasympathetic withdrawal and sympathetic activation. The fall in heart rate immediately after exercise is considered to be a function of the reactivation of the parasympathetic nervous system. Because increased vagal activity has been associated with a reduction in the risk of death.

The relationship between autonomic system and cardiovascular mortality is significant and this study can be used to study the hereditary risk that an individual carry to develop any autonomic dysfunction and its effect on cardiovascular status.

METHODS

A total of 30 subjects and 30 healthy controls were recruited in the study. Their anthropometrical and cardiovascular parameters were recorded. All subjects were normotensive (resting systolic BP-120mmHg and diastolic BP-80mmHg), nondiabetic, and not taking over-the-counter or prescription medications or supplements with primary or secondary cardiovascular effects (e.g., statins, antihypertensives, anticoagulants, antidepressants, etc.).

Subject self-identify as to whether their father or mother have been diagnosed with high BP (diastolic blood pressure greater than 90mmHg or systolic blood pressure greater than 140mmHg on at least three times); a positive response for either (or both) parents were subsequently used to determine family history status. Negative family history indicates that neither parent has high BP and comprise the control group while subjects with a positive family history indicate that either parent has high BP and comprise the test group.

On the day of the experimental visit, subjects were instructed to report to the laboratory having abstained from alcohol, caffeine, and strenuous physical activity for the preceding 24h. Heart rate, blood pressure, weight and height of subjects were measured, and BMI calculated.

After 3 min step test heart rate will be measured in 1, 2, 3 and 5 minute and heart rate recovery index calculated by subtracting maximum heart rate achieved during exercise by heart rate measured in 1, 2, 3 and 5 minute. The heart rate recovery index (HRRI) is calculated by extracting the maximum heart rate during treadmill stress testing from the heart rate in the 1st, 2nd, 3rd, and 5th minutes during the post-exercise resting period.

To perform 3 min step test: Metronome will be set to 96 beats per minute, using 13-inch tall step in each beat following a cadence of up, up, down, down. It will be done for 3 minutes and stop and sit immediately.

RESULTS

The study was conducted in a total of 30 healthy subjects aged between 19 and 26 years of whom all were males. The subjects were divided into two groups as "positive family history of hypertension" and "negative family history of hypertension." Both the groups consisted of a total of 15 subjects. The subjects in positive family history of hypertension group had either of their parents diagnosed with hypertension. The mean age of the positive family history of hypertension and negative history of hypertension group were 22.54±1.24 years and 21.73±1.16 years, respectively. Moreover, there was no significant difference between the groups in terms of body mass index (22.27±2.47 and 23.11±3.10 respectively, p=0.421), resting heart rate (77.73±10.80 and76.67±9.67 respectively, p=0.778), resting SBP (116.67±8.99 and 116.67±8.99 respectively, p=1) and resting DBP (78.00±8.61and 75.33±6.39 respectively, p=0.344) shown in Table 1.

Table 1: Baseline characteristics among groups.

	Positive family history of hypertension	Negative family history of hypertension	P value*
Age, years	22.53±1.24	21.73±1.16	0.80
BMI, kg/m^2	22.27±2.47	23.11±3.10	0.421
Resting HR, beats/min	77.73±10.80	76.67±9.67	0.778
Resting SBP, mmHg	116.67±8.99	116.67±8.99	1
Resting DBP, mmHg	78.00±8.61	75.33±6.39	0.344

*Independent t-test, SPSS-17, BMI- Body mass index, HR- Heart rate, SBP- Systolic blood pressure, DBP- Diastolic blood pressure

Table 2: Distribution of the results of exercise testing among groups.

	Positive family history of hypertension	Negative family history of hypertension	P value*
Maximum HR, beats/min	*141.00±13.86*	138.93±13.02	0.677
Average HR, beats/min	121.73±13.21	116.67±11.43	0.271
HRRI1	43.87±11.54	43.00±18.77	0.88
HRRI2	50.07±10.38	49.07±16.32	0.843
HRRI3	53.33±12.72	53.60±17.56	0.962
HRRI4	55.07±13.25	54.60±14.73	0.928
HRRI5	*56.33±14.58*	54.87±14.93	0.788

*Independent t- test, SPSS-17, HR- Heart Rate, HRRI- Heart Rate Recovery Index

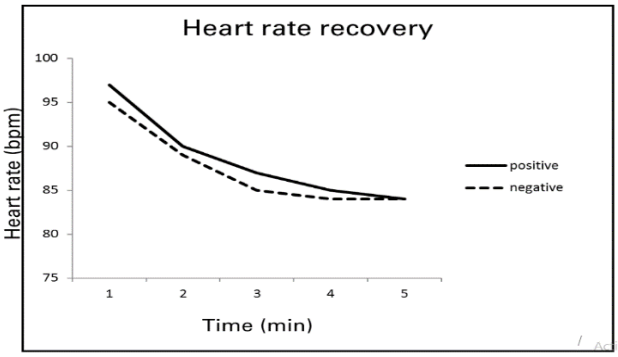

Figure 1: The mean 1st, 2nd, 3rd, 4th and 5th minute heart rate in the positive and negative family history of hypertension groups.

Appropriate records of the subjects in 3minute step test were successfully obtained. No statistically significant difference was observed between the positive family history of hypertension and negative family history of hypertension groups in terms of maximum heart rate (141.00±13.86 and 138.93±13.02 respectively, p=0.677), average heart rate achieved during 3minute step test (121.73±13.21 and 116.67±11.43 respectively, p=0.271). The 1st minute HRRI was not significantly different in the groups (43.87±11.54 and 43.00±18.77 respectively, p=0.88). Likewise the 2nd minute HRRI (50.07±10.38 and 49.07±16.32 respectively, p=0.843), 3rd minute HRRI (53.33±12.72 and 53.60±17.56 respectively, p=0.962), 4th minute HRRI (55.07±13.25 and 54.60±14.73 respectively, p= 0.928) and 5th minute HRRI

(*56.33±14.58* and 54.87±14.93 respectively, p=0.788) were also not significantly different shown in Table 2 and Figure 1.

DISCUSSION

HRRI indicates the degree of post-exercise decrease in the heart rate. In normal asymptomatic subjects and athletes, a rapid decrease is observed within 30s after exercise followed by a slower decrease. While the activation of the parasympathetic nervous system is significant in the decrease observed in the early period of resting, the withdrawal of the sympathetic system is effective on the decrease in the later period.[1] Higher the reduction in the 1st minute was closely related to the lower risk of coronary heart disease and cardiovascular disease.[2]

Our data suggests that in offsprings of hypertension parents there is no dysregulation of autonomic function seen in normotensive person. Subjects with hypertensive and normotensive parents had similar HRRI in the 1st, 2nd, 3rd, 4th and 5th minute. While the peak heart rate achieved by offspring of hypertensive parents were slightly greater than offspring of normotensive parents.

As the present study was conducted in healthy subjects, the medical history of the subjects did not comprise diabetes, hypertension or coronary artery disease. Accordingly, only the effect of family history of hypertension on HRRI after 3minute step test has been investigated.

Another factor that may play a major role early in the pathogenesis of hypertension is augmented sympathetic nerve activity.[3-5] Therefore, several investigators have focused on sympathetic activity in normotensive young offspring of parents with and without hypertension. Yamada et al and Noll et al measured muscle sympathetic nerve activity using microneurography.[5,6] Both groups failed to observe a significant difference in baseline SNA between FH positive and FH negative young adults. Calhoun et al, found that sympathetic reactivity to cold pressure test was unrelated to family history of hypertension in subjects of white ethnicity.[7] Our findings are in accordance with these studies.

There are some limitations. Firstly, our results should be verified in larger studies including a higher number of subjects. Secondly, gas change analysis devices have not been used during stress testing. Thirdly, we included subjects with a BMI of greater than 25kg/m^2. The resulting large BMI range of our subjects might imply obesity as a confounding variable, for which reason potential differences between the two groups may be more difficult to detect. Finally, parameters such as heart rate variability and baroreceptor sensitivity were not used as the indicators of autonomic response during exercise testing.

CONCLUSION

Healthy normotensive young adults with and without a family history of hypertension, did not differ in HRRI in the 1st, 2nd, 3rd, 4th and 5th minutes. These findings suggest that in the absence high arterial pressure and other comorbidities, a family history of hypertension is not accompanied by dysfunction of autonomic system.

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