

Cardiovascular response to isometric handgrip exercise in offsprings of hypertensives-A comparative study

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Abstract

Background: Risk of an offspring becoming hypertensive is several-fold. The need for early detection and change in the lifestyles to prevent future morbidity becomes important.

Hypothesis: Cardiovascular responses to isometric handgrip (IHG) exercise are exaggerated in offspring of hypertensive. Heightened cardiovascular stress responsivity is associated with cardiovascular disease.

Material and Methods: This comparative study was done on 60 first year medical students between the age group of 17-20 years, 30 students whose parents were hypertensives (study group) and 30 students who had no family history of hypertension (control group). Anthropometric characteristics like height (cm), weight (kg), and body mass index (kg/m^2) were recorded. Heart rate (bpm) and blood pressure (mmHg) were recorded before, during, immediately and 2 minutes after isometric hand grip exercise in both the groups. These values were compared by student t-test using SPSS version 11.0.

Results: It was observed that the basal heart rate and blood pressure was high in study group and also the cardiovascular responses to isometric handgrip exercise were exaggerated in offspring of hypertensives as compared to the controls indicating greater sympathetic response to physical stress. The greater sympathetic activity suggests a possible mechanism for future hypertension in them.

Conclusion: The detection of exaggerated cardiovascular response in study group to stress early in life emphasizes the importance of genetic influence on hypertension. Thus can help in early detection of risk of cardiovascular disease and implement changes in the subject's lifestyle to prevent future morbidity.

Key-words: Offspring of hypertensives, Isometric Handgrip exercise, Sympathetic response

Introduction

Hypertension (HTN) is one of the most prevalent and powerful risk factors for cardiovascular disease. It is estimated to affect nearly one-quarter of the adult population and

results in 7.1 million deaths each year [1]. The Global burden of disease study projected HTN as leading cause of death in the year 2020. Thus, it is clear that HTN is an enormous health problem and is one of the biggest health challenge of 21st

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century [2]. In industrialized countries, the risk of becoming hypertensive for an individual with family history of HTN have been estimated to be up to four times higher than average. The risk of cardiovascular death doubles in a linear fashion for each 20/10 mmHg increment in blood pressure (BP) levels above 115/75 mmHg [3]. The current prevalence in many developing countries, particularly in urban societies is already as high as those seen in developed countries. Risk factors for developing HTN, peculiar to Indian population are high familial aggregation. Nearly 75% of the hypertensives have 1st degree family history of HTN indicating a strong familial aggregation [2].

Exercise tests bring about changes in hemodynamics of cardiovascular system [4]. Isometric exercise is performed as part of many daily activities [5] and many occupational tasks. Isometric (static) exercise produces a characteristic increase in Blood Pressure (BP), as first described by Lindhand (1920). This increase was first explained as a mechanical consequence of contracting muscles blocking their own blood supply [6]. Evaluation of circulatory alterations during sustained isometric (stress) muscle contraction is a useful method to assess cardiac function [7]. Heightened cardiovascular stress responsivity is associated with cardiovascular disease [8]. Thus isometric handgrip exercise is a powerful non-invasive screening for cardiovascular disease.

Extensive research has clearly demonstrated familial aggregation of casual BP among first degree relatives, as measured by resemblance of BP levels between parents and offspring and among siblings [9]. In contrast, data regarding the familial aggregation of BP and heart rate (HR) responses to stress are thus limited. Since vascular reactivity response can readily be detected by isometric stress

[10], thus the present study was undertaken to assess cardiovascular response to stress with Isometric Handgrip (IHG) exercise and also to know the risk of offspring of hypertensives developing HTN at early age and to help intervene early.

Material and Methods

A comparative cross sectional study was carried out on 60 apparently healthy first year medical students of SNMC, Bagalkot, in the research laboratory of Department of physiology. Age ranging from 17-20 years, of both gender. 30 students whose parents were hypertensives were selected as study group (cases) and 30 students who had no F/H/O hypertension as Control group and both the groups were matched. Written informed consent was obtained and study was approved by the institutional ethical committee.

Inclusion criteria: Apparently healthy first year voluntary medical students between the age group of 17-20 years, of both sexes with family history of hypertension (first degree).

Exclusion criteria: Subjects not consenting for study, Subjects with gross anaemia, limb deformity, Endocrinal disorders and Psychological disorders, History of acute/chronic infections, recent hospitalization, head trauma, medications, smoking, alcohol, drug abuse and any clinical disease like cardiopulmonary disorder.

Study Protocol: Their health status was ascertained through history taking and clinical examination. Anthropometric characteristics like Height (cm), Weight (kg) were recorded and Body Mass Index (kg/m^2) was calculated, by using the formula- $\text{Weight (kgs) / Height(m}^2\text{)}$. Baseline heart rate (bpm) and Blood pressure (mmHg) were recorded after 10 min of rest. Subjects were asked to perform hand grip

exercise to maximum with Hand grip dynamometer (Inco ltd.) in sitting posture with dominant hand and three readings were recorded and mean of it was taken and then 30% of Maximum voluntary contraction (MVC) was considered. Heart rate and Blood pressure (both systolic and diastolic blood pressure) were recorded during exercise of 2 min, immediately (0 min), and 2 minutes after submaximal (30%) isometric hand grip exercise in both the groups.

Statistical Analysis: All data expressed in terms of mean \pm standard deviation and Statistical analysis was done using software SPSS version 11.0 using student t-test under the guidance of a biostatistician. $P < 0.05$ was taken as significant and $P < 0.001$ was taken as highly significant.

Results

There were total of 60 students divided into two groups - study group (cases) and control group of 30 each, including both gender. The physical characteristics like age, height, weight and Body Mass Index (BMI) of subjects of two groups are as

depicted in Table 1 and Figure 1. Mean BMI of study group subjects was 22.12 kg/m^2 and control group was 21.71 kg/m^2 . Table 2 shows Heart rate (bpm) comparison in study and control group before, during and after Isometric hand grip exercise. Heart rate (HR) before (basal), during and after exercise was higher in study group subjects in comparison with control group. Table 3 depicts mean values of Systolic blood pressure (mmHg) response in study and control group before (basal), during and after Isometric hand grip exercise. Systolic blood pressure (SBP) increased during exercise in both the groups but the increase was more in study group subjects. The increased systolic blood pressure reached to baseline value within 2 minutes in both the groups. Diastolic blood pressure (mmHg) response in study and control group before (basal), during and after exercise is depicted in Table 4. Diastolic Blood pressure (DBP) shows statistically significant increase in study group subjects when compared to control group.

Table 1: Physical parameters of study group (cases) and control group

Parameter	Control group (n=30)	Study group (n=30)	t	P value
Age (yrs)	18.23 \pm 0.817	18.03 \pm 0.809	-0.953	0.345
Height (cms)	168.07 \pm 9.202	162.13 \pm 8.063	-2.656	0.010
Weight (kgs)	61.23 \pm 8.908	58.50 \pm 12.04	-0.999	0.322
BMI (kg/m^2)	21.71 \pm 2.92	22.12 \pm 3.26	0.506	0.615

Values are mean \pm S.D., BMI-Body mass index

Figure 1: Physical characteristics of study group (cases) and controls

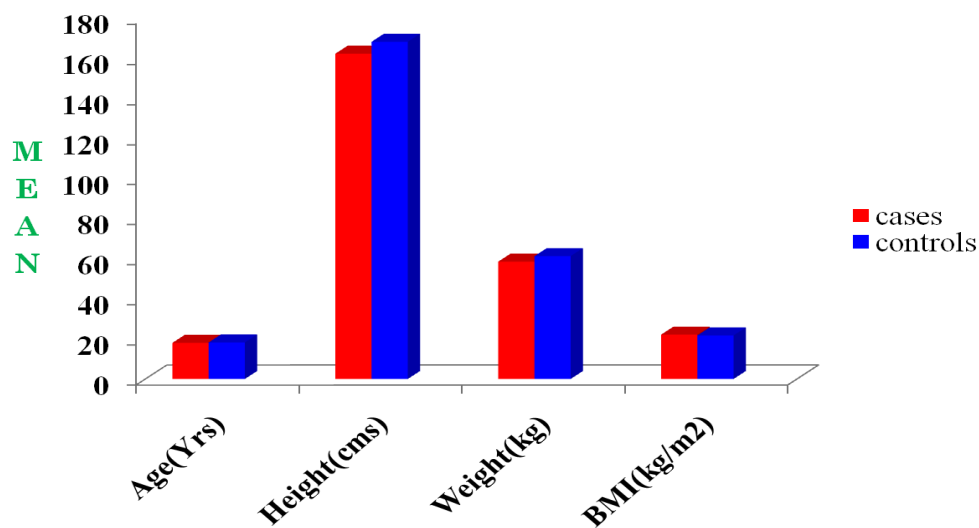


Table 2: Heart rate (HR) comparison in study and control group before, during and after IHG exercise

Heart rate (bpm)	Control group (n=30)	Study group (n=30)	t	P value
Baseline	85.47±8.835	87.33±11.220	0.716	0.477
During exercise	98.40±10.689	104.07±12.553	1.883	0.065
0 min after exercise	88.97±10.591	91.00±12.177	0.690	0.493
2 min after exercise	83.93±8.387	87.50±10.491	1.455	0.151

Values are mean ± S.D

Table 3: Systolic blood pressure (SBP) response in study and control group before, during and after IHG exercise

SBP (mmHg)	Control group(n=30)	Study group(n=30)	t	P value
Baseline	118.80±8.454	119.57±11.218	-0.481	0.632
During exercise	130.47±6.312	132.27±12.512	0.704	0.485
0 min of exercise	120.53±8.661	117.60±12.050	-1.083	0.283
2 min of exercise	115.43±8.050	114.43±11.587	-0.388	0.699

Values are mean ± S.D

Table 4: Diastolic blood pressure (DBP) response in study and control group before, during and after IHG exercise

DBP (mmHg)	Control group(n=30)	Study group(n=30)	t	P value
Baseline	70.47±7.749	71.23±6.857	0.124	0.902
During exercise	81.10±7.765	86.87±10.418	2.431	0.018*
0 min of exercise	69.67±6.814	71.03±9.011	0.663	0.510
2 min of exercise	67.57±6.852	70.23±8.148	1.372	0.175

Values are mean ± S.D; *p<0.05-significant

Discussion

Family history represents the integration of shared genomic and environment risk factors. First degree relatives share half of the genomic information and also behavior, life styles, beliefs, culture and physical environment, so their disease experience may offer a clue to shared susceptibilities. This suggests that a 'low tech' clinical approach-family history-might be a practical and useful way to target interventions and disease prevention efforts to those most at risk.² Risk factors for developing HTN, peculiar to Indian population are high familial aggregation. Nearly 75% of the hypertensives have 1st degree family history of HTN indicating a strong familial aggregation [2].

Isometric (static) exercise produces a characteristic increase in Blood Pressure (BP), as first described by Lindhand (1920). This increase was first explained as a mechanical consequence of contracting muscles blocking their own blood supply [6]. Evaluation of circulatory alterations during sustained isometric (stress) muscle contraction is a useful method to assess cardiac function.⁷ Isometric hand grip exercise test provides pressor stimuli to cardiovascular system through efferent sympathetic pathways with a resultant increase in heart rate and blood pressure [10].

There is association between exercise blood pressure and potential risk of stroke, cardiovascular events and mortality.⁶ Exaggerated BP and HR response to stress tests have been implicated in the etiology of cardiovascular disease [7]. Studies have shown that normotensives with a family history of HTN exhibit altered sympathovagal balance with decreased parasympathetic activity at cardiac level [4].

In the present study, subjects with F/H/O HTN had higher borderline BMI (22.12 ± 3.26) when compared to control group (21.71 ± 2.92), but it was within normal range. This fact shows that these subjects with higher BMI when compared to their counterpart controls suggest the positive association for becoming an increasing risk factor to develop HTN in future [3].

We also found that the study group subjects showed had higher basal (resting) HR, SBP and DBP when compared to control group but this increase was not statistical significant. This could be due to smaller sample size. Dayanand et al [8] also showed similar findings and the increase in BP during rest suggests a true sustained elevated blood pressure, characterizing a permanent abnormality the prehypertensive stage [8]. Studies have shown that those with a parental history of HTN show a higher resting DBP [4]. Lopez et al found higher casual BP and also higher plasma levels of catecholamines before exercise in normotensive offspring of hypertensive parents [11]. Studies suggest that the increased heart rate is related to a withdrawal of vagal inhibition [5].

In present study 30% of maximum voluntary contraction for 2minutes was considered because it is commonly performed with ease and research have shown only modest increases in arterial blood pressure and heart rate [1]. Systolic BP was increased during exercise in study group when compared to control group. Diastolic BP was also increased during IHG exercise in study group when compared to control group and this increase was statistically significant. This exaggerated increase in BP in

study group subjects suggests a greater reactivity of the vessels to physical stress [11]. Lopes et al also showed similar findings and suggested that a greater increase in sympathetic activity in subjects with F/H/O HTN suggest a possible mechanism for future HTN in them [11]. Post exercise Diastolic blood pressure (DBP) though was increased in cases, was not found to be statistically significant. Recovery in DBP of study group was not statistically significant.

Sowmya et al performed heart rate variability test in subjects aged 18-30 years and found that the basal systolic BP and LFnu are higher and HFnu is lower in control group, which may be an early marker of cardiovascular autonomic change in subjects with a genetic predisposition to HTN [4]. Some investigations of the isometric cardiovascular reflex mechanism have suggested that the increase in systemic arterial pressure is in part due to increased alpha adrenergic activity in addition to increase in cardiac output [5].

Sympathetic stimulation causes chronotropic effects by increasing the rate of pacemaker depolarization. In young normotensives subjects, parental HTN is associated with stiffening of the carotid artery and reduction in cardio-vagal outflow and baroreflex gain [8]. Subjects whose resting blood pressure is high will reach higher maximum values during isometric exercise. The duration of the exercise period and the strength of the contraction will also affect how much the blood pressure increases during isometric exercise [16].

Thus exaggerated BP and HR response to stress test have been noted in the study group and included in the effects of cardiovascular disease. Improved cardio-vagal autonomic function and central arterial elasticity may contribute to the lower incidence of hypertension observed in individuals who exercise regularly [8]. The drawback of the

study was we could not measure the plasma catecholamines to assess sympathetic activity and also longitudinal study needs to be done in them, which would compliment and confirm the findings.

Conclusion

We conclude that exaggerated BP response to stress test in study group with F/H/O HTN could be an indication of future development of HTN in them at an early age when compared to controls. Hence, this sincere effort on our part can help in early detection and implement changes in subject's lifestyle to prevent future morbidity who are genetically predisposed to HTN and would also like to suggest the study group to undergo similar exercise stress tests regularly to help them have a check of their cardiovascular status.

Recommendation

Thus we recommend the regular monitoring of blood pressure to offspring of hypertensives and thus practice regular physical activity which is an effective lifestyle intervention for minimizing negative effects of family history of hypertension on cardiovascular system.

References

1. Millar JP, Paashis A, McCartney N. Isometric Handgrip Effects on Hypertension. *Current Hypertension Reviews*.2009;5(1):54-60.
2. Khanna N, Sharma RS, Sidhu RS. A study of the basic and derived anthropometric indices among the healthy adults (20-30 years of age) of Amritsar city (punjab) having family history of hypertension. *Int J Biol Med Res*.2011;2(3):743-746.
3. Choudary S et al. Study of anthropometric parameters in young healthy individuals

- having parental history of hypertension: a study conducted on college going adolescents. *Int J Biol Med Res.* 2011;2(2): 547-550.
4. Soumya R, Maruthy K.N., Gupta R. Cardiovascular Autonomic Responses To Whole Body Isotonic Exercise In Normotensive Healthy Young Adult Males With Parental History Of Hypertension. *Indian J Physiol Pharmacol.* 2009;54(1):37-44.
 5. Fisher ML, Nutter OD, Jacobs W, Schlant R. Haemodynamic responses to Isometric exercise (handgrip) in patients with heart disease. *British Heart Journal.* 1973;35: 422-432
 6. Bakke EF, Hisdal J, Kroese AJ, Jorgensen JJ, Strandén E. Blood pressure response to isometric exercise in patients with peripheral atherosclerotic disease. *Clin Physiol Funct Imaging.* 2007;27(2):109-115.
 7. Laird WP, Fixler E, Huffines FD. Cardiovascular Response to Isometric Exercise in Normal Adolescents. *Circulation.* 1979;59(4):651-654.
 8. Dayanand G, Murthy N. Blood Pressure Changes in Normotensive Subjects With and Without Family History of Hypertension. *JPBS;* 2009:35-37.
 9. Matthews KA et al. Familial Aggregation of Blood Pressure and Heart Rate Responses During Behavioral Stress. *Psychosomatic Medicine.* 1988;50:341-352.
 10. Vijayalakshmi P, Mohan M, Bhavani AB, Patil A, Kumar BP. Modulation of Stress Induced by Isometric Handgrip Test in Hypertensive Patients Following Yogic Relaxation Training. *Indian J Physiol Pharmacol.* 2004;48(1):59-64
 11. Lopes HF et al. Increased sympathetic activity in normotensive offspring of malignant hypertensive parents compared to offspring of normotensive parents. *Braz J Biol Res.* 2008;41(10):849-853
 12. Soudarssanane MB, Karthigeya M, Stephen S, Sahai A. Key Predictors of High Blood Pressure and Hypertension among Adolescents: A Simple Prescription for Prevention. *Indian Journal of Community Medicine* 2006; 31(3): 107-12.
 13. Mathias CJ, Bannister R. Investigation of autonomic disorders. In Bannister R, Mathias CJ eds. *Autonomic failure: A text book of clinical disorders of the autonomic nervous system.* Oxford: Oxford University Press, 1992. p. 266.
 14. Thomas J, Semanya K, Naser WB, Thomas DJ, Gillum RF. Parental hypertension as a predictor of hypertension in black physicians: the Meharry Cohort Study. *J. Natl Med. Assoc* 1990; 82 (6): 409-412.
 15. Rajashekar R K, Nivedita Y, Ghosh S. Blood Pressure Response To Cold Pressure Test In Siblings Of Hypertensives. *Indian J Physiol Pharmacol* 2003; 47(4): 453-458
 16. Williams CA. Effect of muscle mass on the pressor response in man during isometric contractions. *J Physiol* 1991;435:573-584.

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