

Evaluation of Sympathetic Response in Offsprings of Hypertensive and Normotensive Parents

Poonam Karmacharya,¹ Surjit Singh,¹ Indu Tiwari¹

¹Department of Physiology, Manipal College of medical Sciences, Pokhara, Nepal.

ABSTRACT

Background: Disturbances of the autonomic nervous system play a crucial role in the pathogenesis and clinical course of many diseases. Sympathetic response is an exaggerated response to stress. Studies have shown that enhanced sympathetic response to stress is an indication of prehypertensive states. Young offspring of hypertensive parents are a good model for assessing sympathetic reactivity prior to clinical hypertension. The aim of this study is to compare the sympathetic response in normotensive offspring of both hypertensive and normotensive parents.

Methods: 100 young normotensives, non-smoking and healthy students (male and female) of Manipal College of medical science with a family history of hypertension and 100 young normotensives students, non-smoking and healthy with a negative family history of hypertension were enrolled in the study. Blood pressures at rest and after Isometric hand grip test and cold pressor test were measured. Statistical analysis was done to compare the blood pressure at rest and after isometric hand grip exercise and cold pressor test using independent t test.

Results: A statistically significant increase in systolic and diastolic blood pressures were observed in normotensive offspring of hypertensive parents, compared to the normotensive offspring of normotensive parents indicating sympathetic overactivity after isometric hand grip exercise and cold pressor test ($P < 0.001$).

Conclusions: Normotensive offspring of hypertensive parents showed increase sympathetic reactivity after stress was given in the form of isometric hand grip exercise and cold pressor test. Thus, normotensive offspring of hypertensive parents are more likely to develop future hypertension and the risk is greater when both the parents were hypertensive.

Keywords: Cold pressor test; Isometric hand grip test; Sympathetic reactivity.

INTRODUCTION

The autonomic nervous system is responsible for regulating the activity of smooth muscles, heart, glands of gastrointestinal tract, sweat glands, adrenal glands and of certain endocrine organs. A disturbance of the autonomic nervous system in the form of hyperactive sympathetic tone is found in children of hypertensive parents. Studies have shown that if either of the parents is hypertensive then there is 25% chance that the children may become hypertensive and the chance is 50% when both the parents are hypertensive.¹ Recently, it has been found that cardiovascular autonomic responses to exercise in normotensive healthy young adult males with parental history of hypertension shows signs of sympathetic overactivity. Stimuli that raise blood pressure, such as isometric exercise, cold pressor test or mental arithmetic activate mainly sympathetic outflow. The aim of this study was to assess the sympathetic response in normotensive offspring of both hypertensive

and normotensive parents.

METHODS

A prospective cross-sectional study was conducted in Physiology department of Manipal college of Medical sciences, Pokhara, Nepal in between January 2019 to March 2019. Ethical approval was obtained from Institutional Review Committee of Manipal College of Medical sciences, Pokhara, Nepal. 200 students from first semester to sixth semester MBBS of 2016, 2017, and 2018 batches in the age group of 18-30 were recruited for the study. 100 young normotensive, non-smoking and healthy students (male and female) with a family history of hypertension were grouped as "normotensive offspring of hypertensive parents (NH)". 100 young normotensive, non-smoking and healthy students with no family history of hypertension were grouped as "normotensive offspring of normotensive parents (NN)". Subjects were considered offspring of hypertensive parents if

Correspondence: Poonam Karmacharya, Department of Physiology, Manipal College of medical Sciences, Pokhara, Nepal. Email: Poonamkarmacharya@gmail.com, Phone: +9779806622499.

they were aware that one or both parents were taking antihypertensive medicine. Normotensive offspring of hypertensive parents were further divided into normotensive offspring of one parent hypertensive (NH1) and normotensive offspring of both parents hypertensive (NH2). Verbal informed consents were taken from all participants. Subjects with regular athletic activities, history of smoking, hypertension, kidney diseases or any endocrinal disorder were excluded.

The weight of the participants was obtained with a digital weighing scale. The height was taken with reference of a measuring tape pasted on a firm wall with the foot kept upon the firm even surfaced floor. The body mass index (BMI) of a subject was then determined by dividing the weight (kg) by the squared value of height (meter). The Isometric handgrip test (IHGT) was performed by taking the resting blood pressure of the subject in sitting posture in the morning hour between 10-11am after the light breakfast. Blood pressure was taken in the left arm with a sphygmomanometer and stethoscope after the participant was seated in relaxed position for five minutes. Then the subject was asked to apply pressure on hand grip dynamometer for 1 minute with the right hand. Blood pressure was simultaneously recorded from non-exercising arm. The procedure was repeated thrice with 5 minutes interval in between. Cold pressor test (CPT) was then performed by taking the resting BP; the subject was asked to immerse his hand in cold water (temperature maintained between 5°-9°C) for 90s. Blood pressure measurement from other arm was recorded after the subject removed the hand from cold water.

The data were entered in SPSS 17 for analysis. All the results were expressed as mean±standard deviation. Comparison of rise of blood pressure after IHGT and CPT in normotensive offspring of hypertensive and normotensive parents was performed by independent t test. The p-value was considered to be significant if p <0.05, highly significant if P <0.001 and not significant if p>0.05.

RESULTS

The baseline characteristics are compared in Table 1. There were no significant differences in BMI and

other physical indices between two groups. The physical characteristics of subjects of two groups were statistically matched (P>0.05). However, the offsprings of hypertensive parents group (NH) had a higher basal systolic blood pressure (SBP) and diastolic blood pressure (DBP) with P<0.05.

Following isometric handgrip test and cold pressure test, there was significant rise in systolic as well as diastolic blood pressure in NH group compared with the NN group as shown in Table 2.

Table 1. Mean±SD of basic characteristics of normotensive offspring of Normotensive parents (NN) and Normotensive offspring of hypertensive parents (NH).

Variables	NN	NH	P-value
Height(cm)	163.37±8.09	163.87±7.81	0.9
Weight(kg)	61.60±10.95	61.34±10.95	0.8
BMI(kg/m ²)	22.97±3.48	22.58±3.78	0.4
Resting SBP (mm of Hg)	112±8.72	116±8.53	0.002
Resting DBP (mm of Hg)	72±7.46	75.92±6.84	0.001

Table 2. mean ± SD rise in SBP and DBP in NN and NH group after Isometric Hand grip test (IHGT) and cold pressure test (CPT).

BP	IGHT			CPT		
	NN	NH	P value	NN	NH	P value
SBP (mm of Hg)	5.2± 4.09	13.67 ±5.78	<0.001	3.2± 4.82	9.61± 5.87	<0.001
DBP (mm of Hg)	5.4± 3.47	14± 4.90		3.08± 3.66	10.18± 44.92	

Out of 100 normotensive offspring of hypertensive parents, 68 offspring had single parent as hypertensive and 32 had both the parents as hypertensive. Independent t-test showed that there was significant rise in both SBP and DBP in NH2 group than NH1 group after Isometric handgrip test as well as Cold pressor test with p-value less than 0.001 (Table 3).

Table 3. Mean ± SD rise in SBP and DBP after IHG and CPT in normotensive offspring of one hypertensive parent(NH1) and in normotensive offspring of both the parents as hypertensive. (NH2).

BP	IGHT			CPT		
	NH1(68)	NH2(32)	p-value	NH1(68)	NH2(32)	p-value
SBP(mm of Hg)	11.86±4.51	13.67±5.78	<0.001	7.95±5.12	12.78±6.12	<0.001
DBP (mm of Hg)	12.73±4.72	17.03±4.12		8.82±4.36	12.72±5.1	

DISCUSSION

Hypertension runs in families and parental history of hypertension increases the risk of developing hypertension, especially if both the parents are hypertensive. In the present study the resting SBP and DBP were higher in the offsprings of hypertensive parents. The higher SBP and DBP in the offsprings of hypertensive parents appear to be due to hereditary influence. Similar results were observed in several studies where they observed the basal SBP and DBP to be higher in offsprings of hypertensive parents.^{2,3} Increased sympathetic response to stress tilts the balance towards the sympathetic over-activity which in turn indicates a prehypertensive state.⁴ Therefore, it is a need to explore the sympathetic reactivity in children of hypertensive parents.

Autonomic nervous system changes can be affected by variety of confounding factors including gender, lifestyle and environment and may be modulated by family history. Inappropriate increase in sympathetic activity after any kind of challenge in normotensive patients could be indicative of autonomic imbalance preceding the onset of hypertension. Autonomic reactivity to stress has been hypothesized to be a marker of subsequent neurogenic hypertension.⁵ IHGT and CPT are of prognostic importance to determine sympathetic reactivity. Both tests cause peripheral vasoconstriction mediated by adrenergic receptors of sympathetic nervous system. Present study shows that the SBP and DBP rose significantly after IHGT in the offspring of hypertensive parents than the offspring of normotensive parents. Moreover, the likelihood of increased SBP and DBP was much more when both the parents were hypertensive. Present study is consistent with the study done by Pal in 2011 which reveals that the incidence of prehypertension is more prevalent in offspring of two-parent hypertensive.⁶ Similar finding was observed in the study done by Garg R, which showed that during the isometric handgrip exercise test, the rise in the systolic, diastolic and the mean blood pressures was significantly higher in the offsprings of the hypertensive parents.⁷ Similarly, in a study done by Devaki. P.R, there was an increase in the diastolic blood pressure in response to isometric hand grip and mental arithmetic test.⁸ The systolic blood pressure and pulse pressure were higher in normotensive offsprings of hypertensive parents and was not found to be related to increased dietary salt intake in a study done by I.E Tebi.⁹ SBP and DBP were also increased significantly after cold pressor test in this study in offspring of hypertensive parents. Our study

was also inconsistent with the study done by Rathi et al, Pramanik et al and Xu et al., where the sympathetic hyperactivity was higher in offsprings of hypertensive parents.¹⁰⁻¹² The results support the concept of inherited vascular reactivity as an indicator of sympathetic hyperactivity which is more or less a predictor of hypertension. It was found that offspring of hypertensive parents compared with offspring of normotensive parents have higher plasma catecholamine levels and further accentuated by concomitant release of endothelin. Endothelin is a locally released vascular regulator that at very low concentrations enhances contractions to norepinephrine and at higher concentrations has potent direct vasoconstrictor properties.¹³ Increase in the local release of endothelin could alter the activity and vascular effects of the sympathetic nervous system (SNS).

It may be due to this increase activation of SNS which by its vasoconstrictor effects mediates the stress induced increase in blood pressure that may promote the development and progression of the hypertension.

Hypertension is a worldwide major health problem associated with serious complication as hypertensive nephropathy and cardiovascular and cerebrovascular life-threatening events.¹⁴ Early detection of proneness to hypertension may enable an individual to enjoy healthy life by altering his lifestyle. Therefore, if a person realize that he may suffer from hypertension in advance, it will definitely be beneficial.

A number of limitations should be considered when interpreting findings from this study. The groups were made on self-report by students and did not obtain medical records of parents. We did not have information regarding parental hypertension diagnosis (primary or secondary); their specific BP values and medication used. Strict and detailed medical history of parents is needed to confirm our findings. Secondly, the research subjects were college students. Therefore, the findings of our study do not necessarily apply to other populations. Moreover, Heart rate variability (HRV) analysis could be a better choice to measure the autonomic balance.

CONCLUSIONS

Elevated SBP and DBP in response to IHGT and CPT were observed in the offsprings of hypertensive parents. Thus, the latent period of vascular hyperactivity can be detected earlier by these tests so as to implement early preventive measures to halt the progression of hypertension in the future.

ACKNOWLEDGMENT

I would like to acknowledge Manipal College of Medical sciences, Pokhara, Nepal for all the technical and scientific support. I would also like to thank all the volunteers who actively took part in this study.

REFERENCES

- Goldstein IB, Shapiro D, Weiss RE. How family history and risk factors for hypertension relate to ambulatory blood pressure in healthy adults. *J Hypertens*. 2008 Feb 1;26(2):276-83. [\[FullText\]](#)
- Kumar A, Rathi P, Agarwal V, Saluja N, Choudhary S. Comparison of cold pressor test in children of hypertensive and non hypertensive parents. *Journal of Evolution of Medical and Dental Sciences*. 2015 Sep 14;4(74):12819-23. [\[Link\]](#)
- Lopes HF, Consolim-Colombo FM, Barreto-Filho JA, Riccio GM, Negrão CE, Krieger EM. Increased sympathetic activity in normotensive offspring of malignant hypertensive parents compared to offspring of normotensive parents. *Braz J Med Biol Res*. 2008 Oct;41(10):849-53. [\[DOI\]](#)
- Brook RD, Julius S. Autonomic imbalance, hypertension, and cardiovascular risk. *Am J Hypertens*. 2000 Jun 1;13(5):112S-22S. [\[FullText\]](#)
- Dekkers JC, Treiber FA, Kapuku G, Snieder H. Differential influence of family history of hypertension and premature myocardial infarction on systolic blood pressure and left ventricular mass trajectories in youth. *Pediatrics*. 2003 Jun 1;111(6):1387-93. [\[DOI\]](#)
- Pal GK, Pal P, Nanda N, Lalitha V, Dutta TK, Adithan C. Sympathovagal imbalance in prehypertensive offspring of two parents versus one parent hypertensive. *Int J Hypertens*. 2011 Oct 23;2011. [\[DOI\]](#)
- Garg R, Malhotra V, Dhar U, Tripathi Y. The isometric handgrip exercise as a test for unmasking hypertension in the offsprings of hypertensive parents. *J Clin Diagn Res*. 2013 Jun;7(6):996. [\[DOI\]](#)
- P.R Devaki, Saikumar P, K. Anushri. Evaluation of cardiovascular sympathetic reactivity in Normotensive offspring of Hypertensive parents. *IOSR Journal of Dental and Medical Sciences*. 2013; 4:1-3. [\[Link\]](#)
- El Tebi I, Baligh E, Gamal H, Ashour Z, Youssef G, Shahata A, Mokhtar M. Young normotensive offspring of hypertensive parents have higher systolic blood pressure unrelated to dietary salt intake. *European Heart Journal*. 2013 Aug 1;34(suppl_1). [\[DOI\]](#)
- Rathi P, Agarwal V, Kumar A. Sympathetic hyperactivity in children of hypertensive parents. *Ann Neurosci*. 2013 Jan;20(1):4. [\[DOI\]](#)
- Pramanik T, Regmi P, Adhikari P, Roychowdhury P. Cold pressor test as a predictor of hypertension. *The Journal of Tehran University Heart Center*. 2009;4(3):177-80. [\[Link\]](#)
- Xu R, Zhang X, Zhou Y, Wan Y, Gao X. Parental overweight and hypertension are associated with their children's blood pressure. *Nutrition & Metabolism*. 2019;16(1):35. [\[DOI\]](#)
- Dong Y, Wang X, Zhu H, Treiber FA, Snieder H. Endothelin-1 gene and progression of blood pressure and left ventricular mass: longitudinal findings in youth. *Hypertension*. 2004 Dec 1;44(6):884-90. [\[DOI\]](#)
- Wang NY, Young JH, Meoni LA, Ford DE, Erlinger TP, Klag MJ. Blood pressure change and risk of hypertension associated with parental hypertension: the Johns Hopkins Precursors Study. *Arch Intern Med*. 2008 Mar 24;168(6):643-8. [\[DOI\]](#)