SHORT COMMUNICATION

Evaluation of Cardiovascular Responses Using Cold Presser Test as a Possible Future Risk for Hypertension in Normotensive Healthy Young Subjects

Naila Parveen[1*], Syed Hafeezul Hassan[1], Shireen Jawed[1], Beenish Iqbal[1], Umaima Rafiq[1] and Vineesha FNU[1]

[1]*Department of Physiology, Liaquat National Medical College, Karachi, Pakistan*

Abstract

Hypertension is a major public health challenge and an emerging factor for cardiovascular co-morbidities globally. Exaggerated cardiovascular response to stress has been possible evidence to be a future risk for the development of hypertension and cardiac disorders. This cross-sectional study was done to evaluate cardiovascular responses using a cold presser test as a possible future risk for hypertension in normotensive healthy young students.A total of 70 healthy medical students of first-year MBBS, of both genders with ages between 18-22 years were included in the study. About 68.6% of students were found to be normal and were included in the normal response group. They showed no significant increase in heart rate, systolic or diastolic blood pressure. The participants showing a rise of systolic BP ≥25 mmHg or diastolic BP ≥20 mmHg were included in the hyper-response group.The overall mean age group in both male and female students was 20±1.56 years. In conclusion, 31.4% of normotensive medical students showed exaggerated cardiovascular responses to cold pressor tests which can be apossible risk for hypertension in these young normotensive individuals. Early interventions in their lifestyle modification can prevent them from developing hypertension in the future.

Keywords: *Coldpressor test, hyper response, hypertension.*

INTRODUCTION

Hypertension, also known as an increase in blood pressure, is a chronic and lifelong disease and poses a major risk for premature deaths worldwide. It is highly prevalent affecting up to an estimated 1.4 billion adults all over the globe and a reported prevalence of 31% [1].

The classification of hypertension includes both the primary and secondary types. Primary hypertension represents the vast majority > 90% of all cases. The pathophysiological determinants of primary hypertension are genetic and environmental factors. Family history, inadequate physical fitness, uncontrolled weight and unhealthy dietary habits are causative factors leading to hypertension. Interventions such as early detection, awareness and lifestyle modifications can play a pivotal role in the control of high blood pressure and improvement in the quality of life of an individual [2].

Uncontrolled and persistent high blood pressure has a major impact on multiple bodily systems such as the brain, heart, kidney and other organs which would lead to comorbidities such as heart failure, stroke and chronic kidney disease. According to the U.S. Preventive Services Task Force Recommendation Statement, screening for high blood pressure is recommended in adults aged 18 years or older that would greatly reduce the incidence of cardiovascular events by early health care intervention [3].

Empirical evidence from previous research studies has hypothesized that dysfunction in the sympathetic part of the autonomic nervous system fails to control blood pressure due to increased levels of adrenergic neurotransmitters [4].

The cold pressor test relates to an individual's response to temperature and environmental stressors such as exposure to a cold environment and its effect on cardiovascular function. Physiologically, the autonomic nervous system plays an important role during sudden temperature changes. Immersing hand in ice-cold water causes sympathetic activation through noradrenaline release resulting in a pressor response which includes constriction of arterioles, elevated heart rate, myocardial contraction and increased blood pressure (BP). Thus, the overall effect of these responses results in the elevation of blood pressure [5-7].

Thus, evaluation of pressor responses to cold stress in a subject can be a useful predictor for the development of hypertension in the future. Therefore, subjects with an exaggerated stress response can be detected earlier and can be prevented from developing hypertension in the future by early lifestyle interventions[8-11].

A study in children was performed using the cold pressor test as a predictor for cardiovascular health,

**Corresponding Author: Naila Parveen, Department of Physiology, Liaquat National Medical College, Karachi, Pakistan;*
Email: m_naila72@yahoo.com
Received: October 10, 2020; Revised: November 11, 2020; Accepted: December 12, 2020
DOI: https://doi.org/10.37184/lnjpc.2707-3521.2.12

suggested that those children exposed to physically active outdoor games showed a better cardiovascular response to the cold pressor test compared to those who were indulged more in indoor static activities such as video games and watching television [12].

The significance of our study is to predict the increased risk for the future development of hypertension in normotensive individuals and to seek preliminary cautious measures for the prevention of cardiovascular morbidity in the young population.The main aim of this study was to evaluate cardiovascular response such as blood pressure and heart rate changes during cold presser test as a possible future risk for hypertension in normotensive healthy young students.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Physiology at Liaquat National Medical College, Karachi after approval from the institutional review board. The total duration of the study was from February 2017 to August 2017. A total of 70 healthy medical students of first-year MBBS, both genders (35 males and 35 females) with ages between 18-22 years were included after approval from the concerned ethical review board and taking informed written consent. Moreover, the participants were informed about the design and methodology of the study. Students having a previous history of cardiovascular or neurological disorders and smokers were not included in the study.

The equipment used in the cold pressor test included a deep water pan filled with ice to maintain a temperature of 4°C using a mercury-in-glass thermometer, radial arm electronic sphygmomanometer, pulse oximeter and a stopwatch. Each subject was asked to lay down for five minutes. BP and HR were measured three times each before and during immersion. Before immersion, three readings of blood pressure were taken and then their average was obtained. Then, a deflated BP cuff was left on the wrist. The right hand without the cuff was immersed in the ice water, and left for 2 min. Blood pressure and heart rate were determined after every thirty seconds for two minutes and the individual was then asked to remove the hand from the cold water.

The average pressures obtained before immersion were subtracted from the maximum reading during immersion. The differences between the blood pressures were recorded. Individuals with a Systolic BP difference of ≤ 25 mmHg(post immersion BP- pre-immersion BP) and diastolic BP difference of ≤ 10 mmHg were categorized as normal response groups and those whose BP differed from a rise of systolic BP ≥ 25 mmHg or diastolic BP ≥10 mmHg were labeled as hyper response group [13]. Heart rate was recorded by attaching the participant's finger with the pulse oximeter both before immersion and during immersion.

Statistical analysis was done on SPSS 21. The mean blood pressure and heart rate of each participant were calculated on the datasheet and based on their values; students were divided into normal response group and hyper-response group. An independent sample t-test was performed to find out a significant difference between the mean blood pressure and heart rate of both groups.

RESULTS

A total of seventy healthy medical students of both genders were included in the study. The mean age group in both male and female students was 20±1.56 years (Table **1**). 31.4% of the students were categorized as hyper-responsive. Among males, the frequency of normal response was significantly higher (52.1%) than hyper-response (45.5%) while among females, the proportion of hyper-response was higher (54.5%).Mean heart rate in the normal response group was 78±6.53 beats/min and in the hyper response group, it was 103±7.88 beats/min after immersion and the difference was statistically significant (p=0.020). Average systolic blood pressure in the hyper response group was 134±8.84 which was significantly higher than the average systolic blood pressure in the normal response group (112±9.78). Mean differences in diastolic blood pressure among the two groups was not statistically significant (Table **1**).

Table 1: Comparison of participants' characteristics between normal and hypertensive group.

Study Variable	Normal Response-Group n=48	Hyper-Response Group n=22	P value
Age (in years)#	20±0.715	20± 0.722	0.800
Gender			
Male; n(%)	25 (52.1)	10 (45.5)	*0.001
Female; n(%)	23 (47.9)	12(54.5)	
Mean systolic blood pressure (mmHg) #	112±9.78	134±8.84	0.001*
Mean diastolic blood pressure (mmHg) #	76±7.58	82±8.32	0.060
Mean heart rate (beats/min) #	78±6.53	103±7.88	*0.020

#: variables are presented as mean ± standard deviation; *Significant at p<0.05

DISCUSSION

This cross-sectional study was conducted in young healthy medical students to evaluate their cardiovascular response using the cold pressor test as a predictor of hypertension.

In this study, 31.4% of the students showed a mean difference of > 25mmHg in the systolic blood pressure and a mean diastolic blood pressure difference of > 10 mmHg and were categorized as a hyper-responsive group with a ratio of hyperresponsive to normoresponsive 1:2. These findings were in agreement with the study conducted by Mathews *et al.* According to his follow-up study, normotensive participants who showed large responses to stress (cold used as a stressful stimulus), were at a higher risk for hypertension [14].

In another study conducted by Mythri *et al.* reported the cardiovascular response to the cold pressor test and found 36.7% of the study subjects to be hyper-reactors[15].

In our study, there was a significant increase in systolic blood pressure in the hyper response group which was not in agreement with the findings of Banoo *et al.* None of the study participants showed any significant increase in the systolic or diastolic blood pressure [16].

Our results did not show significant mean differences in diastolic blood pressure between the normal response and hyper response groups. These findings were in contrast with Hada *et al.* who observed a significant rise in the diastolic blood pressure during the cold pressor test in pre-hypertensive individuals compared to normotensive students [17].

According to our study results, male and femaleresponses to the cold pressor test were not statistically significant. Though, the inconsistent study of Laura Mitchellin Glasgow reported gender differences, with men tolerating the stimulus for significantly longer than women [18].

CONCLUSION

This study suggested that 31.4% of the students were reported to show an increase in both the heart rate and blood pressure in response to the cold pressor test. Future recommendations of lifestyle modification in these students can prevent them from developing hypertension.

LIMITATIONS OF THE STUDY

In this study, only young adults were included. The cardiovascular responses should have been evaluated in different age ranges to predict hypertension in older individuals.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

Declared none.

REFERENCES

1. Forouzanfar MH, Liu P, Roth GA, Ng M, Biryukov S, *et al.* Global burden of hypertension and systolic blood pressure of at least 110 to 115 mm Hg. JAMA 2017; 317: 165-82.
2. Carey RM, Muntner P, Bosworth HB, Whelton PK.Prevention and control of hypertension. J Am Col lCardiol 2018; 72(11): 1278-93.
3. Siu AL, U.S. Preventive Services Task Force.Screening for high blood pressure in adults: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med 2015;163: 778-86.
4. Mancia G, Grassi G.The autonomic nervous system and hypertension.Circ Res 2014;114: 1804-14.
5. Velasco M, Gomez J, Blanco M, Rodriguez.The cold pressor test: pharmacological and therapeutic aspects. Am J Ther 1997; 4: 34-8.
6. Sun Z. Cardiovascular responses to cold exposure. Front Biosci (Elite Ed) 2010;2: 495-503.
7. Wood DL, Sheps SG, Elveback LR, Schirger A. Cold pressor test as a predictor of hypertension. Hypertension 1984; 6: 301-6.
8. Silverthorn DU, Michael J. Cold stress and the cold pressor test. Adv Physiol Educ 2013; 37: 93-6.
9. Wirch JL, Wolfe LA, Weissgerber TL, Davies GAL. Cold pressor test protocol to evaluate cardiac autonomic function. Appl Physiol Nutr Metab 2006; 31: 235-43.
10. Zhao Q, Bazzano LA, Cao J, Li J, Chen J, Huang J, *et al.* Reproducibility of blood pressure response to the cold pressor test: the gen salt study. Am J Epidemiol 2012; 176(7): 91-8.
11. Elfakharany AT, El Azab DR, Khaled SAA. Response to cold pressor test in normotensive adult females. Int J Adv Res Biol Sci 2016;3(10): 219-24.
12. Rauber SB,Boullosa DA,Carvalho FO,deMoraes JFVN, de Sousa IRC, Simões HG, *et al.* Traditional games resulted in post exercise hypotension and a lower cardiovascular response to the cold pressor test in healthy children. Front Physiol 2014; 5:235.
13. Karia RM, Rajput MH, Mehta HB, Gokhale PA. Blood pressure response to cold pressure test in normal young healthy subjects: a prediction of future possibilities of hypertension. J Phys Pharm Adv 2012; 2(6): 223-6.
14. Matthews KA, Katholi CR, McCreath H, Whooley MA, Williams DR, Zhu S, *et al.* Blood pressure reactivity to psychological stress predicts hypertension in the CARDIA study. Circulation 2004; 110: 74-8.
15. Mythri G, Quadri SS. Effect of cold pressor test on blood pressure in normotensives and hypertensives. Natl J Physiol Pharm Pharmacol 2018; 8(2): 177-81.
16. Banoo H, Gangwar V, Nabi N. Effect of cold stress and the cold pressor test on blood pressure and heart rate. Int Arch BioMed Clin Res 2016; 2(2): 65-8.
17. Hada S, Amatya S, Shrestha RK. Cold pressor test in borderline hypertensive university students. Kathmandu Univ Med J 2016; 56(4): 337-41.
18. Mitchell LA, MacDonald RAR, Brodie EE. Temperature and the cold pressor test. J Pain 2004; 5(4): 233-7.