Cold Pressor Test in Borderline Hypertensive University Students

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ABSTRACT

Background

Hyperactive sympathetic reaction is an important factor for development of hypertension in young individuals. The stress induced increase in blood pressure recovers within very short period of time and those with exaggerated stress induced cardiovascular response at young age have a high risk of blood pressure elevation in future.

Objective

To determine the cardiovascular reactivity in response to cold and to correlate its relation with factors such as smoking, family history and physical activity.

Method

Study was conducted in the Department of Pharmacy, Kathmandu University from July to November, 2015. Resting blood pressure was recorded using sphygmomanometer in sitting position after 5 minutes of rest. Out of 130 volunteers, 34 were found to be prehypertensive and equal number of normotensive were recruited randomly to perform the test. The subjects were directed to immerse his/her right hand up to the wrist in cold water of 10˚C for 1 minute. The blood pressure was recorded just before the hand was taken out of the water and then 1.5 minutes and 4 minutes after the withdrawal. Data was analyzed by Student's t test using Microsoft Excel 2007.

Result

Systolic and diastolic blood pressure increased significantly after cold pressor test in both normal (systolic blood pressure from 110±6.46 to 119±9.45 mmHg and diastolic blood pressure from 71±4.63 to 78±6.15 mmHg) and prehypertensive group (systolic blood pressure from 122±6.75 to 126±8.05 mmHg and diastolic blood pressure from 79±6.78 to 85±7.76 mmHg). Maximum recovery in both systolic and diastolic blood pressure was observed in 2.5 minutes of removal of hand from cold water. Though sharp drop was observed in blood pressure at the end of 2.5 minute in both groups of individuals, the recovery in case of prehypertensive individual was not sharper. In the present study, significant rise in diastolic blood pressure was observed in prehypertensive smoking males. Also the difference was significant ($p<0.02$) in recovery of diastolic blood pressure between smoker and non smoker prehypertensive group.

Conclusion

This study suggests that prolonged elevation in blood pressure in response to stress in young individual can be used as marker of development of hypertension in future. Adopting a healthier lifestyle can help to delay the development of hypertension in later life.

KEY WORDS

Cold pressor test, hyperreactors, hypertension

INTRODUCTION

Hypertension (HTN), a major global non communicable disease, with an estimation of one quarter of adults suffering from it worldwide is predicted to increase by about 60% in 2025.[1] Studies have reported that, in Nepal, out of total cardiovascular diseases nearly half suffered from hypertension and its prevalence has been increasing significantly with improved socioeconomic status.[2,3] It is suggested that cardiovascular reactivity to stress could be used for prediction of development of hypertension.[4,5]

Hyperactive sympathetic reaction is an important factor for development of hypertension in young individuals.[6] Cold Pressor Test (CPT) is a simple, noninvasive and reliable test to evaluate autonomic status of the body. It is known to cause overall sympathetic activation without change in heart rate and is useful indicator of future hypertension.[7,8] Studies have reported that the stress induced increase in blood pressure (BP) recovers within very short period of time (5 minutes).[9] Additionally, those with exaggerated stress induced cardiovascular response at young age have a high risk of BP elevation in future.[10] Early diagnosis would be beneficial to delay the onset of cardiovascular complication by adopting healthy lifestyle.[11]

The study aims to determine the cardiovascular reactivity in response to cold and to correlate its relation with factors such as smoking, family history and physical activity.

METHODS

The present cross sectional study was conducted in the Department of Pharmacy, Kathmandu University from July, 2015 to November, 2015. One hundred thirty pharmacy students of age group 21 to 24 volunteered in the study after explaining the protocol in detail. The sample size was estimated to be 116 using the standard statistical procedure. Ethical approval was granted by institutional review committee and written consent was taken from the volunteers. Self reported individuals with chronic illness or those taking drug known to influence BP was excluded from the study.

The experiments were done by the same person in room temperature with volunteers after light breakfast and suitable clothes.

Height and weight was measured and BMI was categorized according to WHO classification.[12] Questions related to the dietary habits, physical activity, family history of diabetes and hypertension were asked. Blood pressure was recorded using sphygmomanometer in sitting position after allowing subject to rest for 5 minutes. Subjects were divided into two groups: normotensives and prehypertensives according to Joint National Committee (JNC 7) classification of BP. Out of 130 volunteers, 34 prehypertensives and equal number of normotensives were recruited randomly to perform the cold pressor test.

Cold pressor test was performed in sitting position. After recording the resting BP, the subject was directed to immerse his/her right hand up to the wrist in cold water of 10˚C for 1 minute. The blood pressure was recorded just before the hand was taken out of the water and then 1.5 minutes and 4 minutes after the withdrawal of hand from cold water.[13,14] The subject was instructed to indicate to the investigator if he/she was not able to keep his/her hand immersed in water for required time. The difference between resting BP and 1 min BP after CPT was taken as elevated BP and the difference between 1 minute BP and 2.5 min BP was considered as recovery BP. Data collected was analysed using Microsoft Excel 2007. Values are given as Mean ± Standard Deviation (SD). Student's t test was used to compare the result taking $p<0.05$ as significant.

RESULTS

One hundred thirty volunteers participated in the study, out of which 34 were prehypertensive. Cold pressor test was performed to this group of 34 participants and equal number of healthy volunteers of same age group was taken as their counterparts. Weight, BMI and resting BP differed significantly in two groups (Table 1). Variation in systolic blood pressure (SBP) and diastolic blood pressure (DBP) during CPT is given in Figure 1 and Figure 2 respectively. Tirteen prehypertensive and 14 from normal group were diastolic hyperreactors whereas 1 prehypertensive and 5 normal volunteers were systolic hyperreactors.

Table 1. Anthropometric parameters and resting blood pressure.

Category	Normal (Mean±SD)	Prehypertensive (Mean±SD)	p value
Age (years)	21.50±1.20	21.80±1.32	0.2
Height (m)	1.70±0.08	1.70±0.90	0.7
Weight (kgs)	56.30±6.90	63.10±9.20	0.00
BMI (kg/m2)	20.20±2.61	22.40±3.21	0.00
Systolic BP (mmHg)	110±6.46	122±6.75	0.00
Diastolic BP (mmHg)	71±4.63	79±6.78	0.00

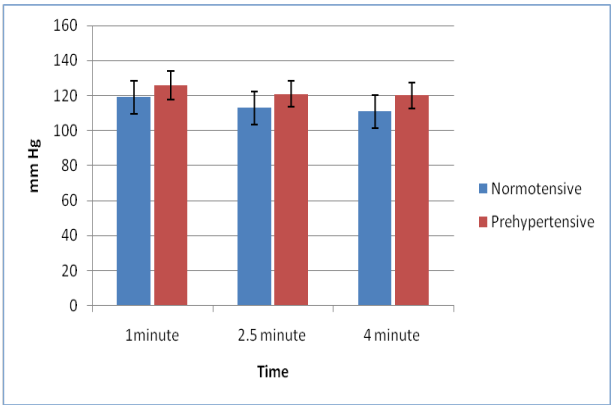

Figure 1. Variation in SBP during cold pressor test

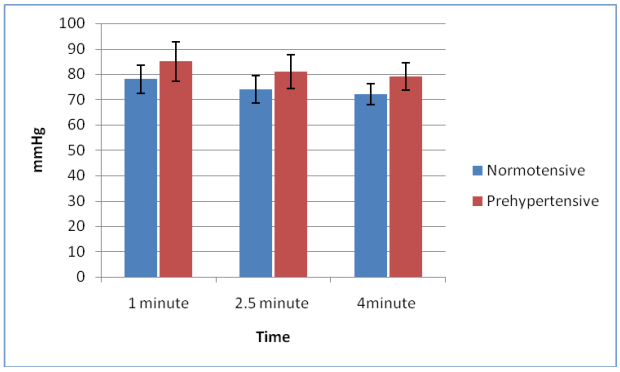

Figure 2. Variation in DBP during cold pressor test

SBP and DBP increased significantly after CPT in both normal and prehypertensive group ($p<0.05$). The maximum SBP and DBP recorded 1 minute after CPT in Normotensive group was 119±9.45 mmHg and 78±6.16 mmHg whereas in Prehypertensive group, the values obtained were 126±8.05 mm Hg and 85±7.76 mmHg respectively.

Interestingly, maximum change in both SBP and DBP was observed in 2.5 minutes of removal of hand from cold water. Since no considerable difference was observed between the recovery in both pressures in 2.5 and 4 minutes, the values of 2.5 minutes were taken into consideration for the further studies (Table 2). Although there was sharp drop in both SBP and DBP at the end of 2.5 minute in both group of individuals, the recovery in case of prehypertensive individual was not as much sharp as in case of SBP (difference of 8 mmHg in normal compared to 6 mmHg in prehypertensive)

Table 2. Comparison of elevated and recovery BP in Normal and Prehypertensive individuals.

	Condition	SBP(mmHg)	p value	DBP(mmHg)	p value
Normal	Resting	110±6.46	0.00	71±4.63	0.00
	1 minute	119±9.45		78±6.15	
Pre hyper-tensive	Resting	122±6.75	0.03	79±6.78	0.00
	1 minute	126±8.05		85±7.76	
Normal	1 minute	119±9.45	0.01	78±6.15	0.00
	2.5 minute	113±8.32		74±5.46	
Pre hyper-tensive	1 minute	126±8.05	0.01	85±7.76	0.01
	2.5 minute	121±7.28		81±6.7	

In this study, none of the females were smokers. Among 13 male smokers, 8 were normotensive and 5 were prehypertensive. In prehypertensive smokers, notable change was only observed in DBP as shown in table 3.

In the present study, there were no exercising females in Prehypertensive group. Few (n=5) females in normal group were physically active but we found no significant differences in their CPT result ($p<0.05$)

In consideration of physical activity (Table 4) and family history of hypertension (Table 5) among normal and prehypertensive individuals, we found no major differences between elevated and recovered blood pressures.

Table 3. Comparison on elevated BP and recovery BP between Male smokers and non smokers

Volunteer	Condition	Mean ± SD	p value
Normal (smoker vs nonsmoker)	Systolic elevated (mm Hg)	9.5± 7.8	0.40
	Systolic recovery (mm Hg)	5±4.7	1.0
	Diastolic elevated (mm Hg)	6.7±5.8	0.10
	Diastolic recovery (mm Hg)	4±4.3	0.09
Prehyperten-sive (smoker vs nonsmoker)	Systolic elevated (mm Hg)	5.0±5.6	0.71
	Systolic recovery (mm Hg)	5.2±4.8	0.2
	Diastolic elevated (mm Hg)	5.1±6.1	0.00
	Diastolic recovery (mm Hg)	3.7±5.3	0.02

Table 4. Comparison on elevated BP and recovery BP between physically active and inactive Male

Volunteer	Condition	Male Mean ± SD	p value
Normal (active vs inactive)	Systolic elevated (mm Hg)	9.5±7.8	0.56
	Systolic recovery (mm Hg)	4.5±4.5	0.09
	Diastolic elevated (mm Hg)	7.7±3.7	0.54
	Diastolic recovery (mm Hg)	5.5±3.5	0.06
Prehypertensive (active vs inactive)	Systolic elevated (mm Hg)	5.1±5.6	0.68
	Systolic recovery (mm Hg)	5.2±4.8	0.98
	Diastolic elevated (mm Hg)	5.1±6.1	0.29
	Diastolic recovery (mm Hg)	3.8±5.1	0.54

DISCUSSION

Study of cardiovascular reactivity using CPT is commonly used to determine the sympathetic influence on vasculature.[7,10,15] Exposure to cold stimulates sympathetic nerve fibers which contains vasoconstrictor agent; neuropeptide Y causing arteriolar constriction and thus rise in blood pressure.[9]

In the present study, prehypertension was found in 23% of total sample population. Similar result was obtained in the other studies done in age group of 20 to 25 years of individual.[16,17]

Significant rise in BP was recorded after CPT as has been observed in the previous studies from country and abroad.[7-9,16]

Table 5. Comparison on elevated BP and recovery BP between individuals with and without family history of HTN

Volunteer	Condition	Male (Mean ± SD)	p value	Female (Mean ±SD)	p value
Normal Volunteer with vs without family history of HTN	Systolic elevated (mmHg)	24±7.8	0.2 (NS)	30±6.4	0.19
	Systolic recovery (mmHg)	14±4.7	0.3(NS)	30±8.2	0.86
	Diastolic elevated (mmHg)	14±3.7	0.3(NS)	20±6.8	0.5
	Diastolic recovery (mmHg)	12±3.6	0.5(NS)	30±7.1	0.19
Prehypertensive Volunteer with vs without family history of HTN	Systolic elevated (mmHg)	18±5.6	0.7(NS)	10±5.3	0.6
	Systolic recovery (mmHg)	16±4.8	0.6(NS)	14±6.1	0.8
	Diastolic elevated (mmHg)	16±6.0	0.8(NS)	20±8.2	0.6
	Diastolic recovery (mmHg)	14±5.3	0.9(NS)	14±6.0	0.5

Individuals with elevation in SBP 15 mmHg or more and DBP 10 mm Hg or more from the baseline after CPT are called systolic and diastolic hyperreactors respectively.[8] Out of the total diastolic hyperreactors more than half of them were male. Among normal diastolic hyperreactors few were smokers, 50% had family history of hypertension and 43% among them were physically active though not regular. When the same parameters were compared with prehypertensive group, it was found that none were smokers, more than one quater had a family history of HTN and were physically active. These findings suggest that an underlying history of familial hypertension may contribute towards diastolic hyperreactivity although in our study significant relation between CPT and family history of hypertension was not found (Table 5). As sympathetic hyper reactivity is associated with early onset of future hypertension,[9] these individuals were explained about the consequences of having elevated BP at young age and were suggested to modulate their lifestyle.

In the present study, significant rise in DBP ($p<0.00$) was observed in prehypertensive smoking males. Also the difference was significant in recovery of DBP ($p<0.02$) between smoker and non smoker prehypertensive group. This finding collaborates with the findings of Malge et al. where rise in DBP ($p<0.001$) was significant than rise in SBP ($p<0.02$).[19] Elevation in pulse rate, BP and reduced peripheral blood flow has been observed with smoking.[18] Smoking increases the sensitivity of sympathetic nervous system due to nicotine.[19,20] Individuals showing prolonged responsiveness to DBP in response to CPT are at high risk of hypertension in future.[11] Compromised recovery of DBP after test may be due to decrease in endothelium derived Nitric oxide in smokers in dose dependent manner.[21-23]

It is a well known fact that regular exercise can lower blood pressure by causing Nitric Oxide dependent vasodilation.[24] Contrary to the previous study,[25] in our study we found no noteworthy association between physical activity and vascular reactivity during CPT. This could be attributed to the fact that most of our volunteers were campus residents of Dhulikhel; a hilly region, where moderate level of physical activity is expected. Even those volunteers who reported that they were physically active had irregular and moderate exercising habits. Additionally, most of the physically active males (normal and prehypertensive) were smokers. Smoking caused a significant alteration in diastolic reactivity (Table 3) and hence, this could probably have an influence on the effect of exercise on CPT causing no significant difference. Thus, physical activity may not have had a profound effect in our study. Moreover, there is similar study done in normotensive young adult African American males which has also suggested that regular physical activity may not play a major role to a reduced blood pressure response to cold pressor test.[26]

In our study, the numbers of physically active volunteers were few as were the number of volunteers who smoked. In case of female volunteers, blood pressure may have been influenced by the time of their menstrual cycle which was not taken into consideration in our study.[27]

CONCLUSION

The result of this study suggests that there is an elevation in blood pressure in response to cold pressor test with diastolic blood pressure increasing significantly in prehypertensive young individuals. Adopting a healthier lifestyle can help to delay the development of hypertension in later life.

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