



Cold Pressor Test as a Predictor of Hypertension

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Received 28 September 2008; Accepted 6 April 2009

Abstract

Background: Early detection of proneness to hypertension may help an individual to lead a healthy life by altering the life style. Subjects having the predisposing factors of hypertension tend to show higher and prolonged responsiveness to blood pressure following stress.

Methods: Normotensive, non-smoking healthy sedentary male students and staff of Nepal Medical College (n=50, age group 18-35 years) participated in the study, conducted between May 2008 and June 2008. Participants with hypertensive parents, either or both, were considered volunteers from hypertensive families. The cold pressor test was carried out. The changes in blood pressure and heart rate among the volunteers of the hypertensive and normotensive families were compared using Student's t-test.

Results: In the present study, sympathetic stimulation exerted through the cold pressor test resulted in an elevation of blood pressure and heart rate in all the young male normotensive individuals. Blood pressure and heart rate returned to the baseline 5 minutes after the withdrawal of the stressor in the cases of the volunteers with no history of familial hypertension. On the other hand, the subjects whose parents, either or both, were reported to be hypertensive showed elevated diastolic blood pressure even 5 minutes after the withdrawal of the stressor.

Conclusion: The present study revealed that the normotensive young male subjects who presented prolonged elevated diastolic pressure in response to sympathetic stimulation through the cold pressor test were prone to develop hypertension in the future.

J Teh Univ Heart Ctr 3 (2009) 177-180

Keywords: Hypertension • Early diagnosis • Sympathetic nervous system

Introduction

Hypertension, a burning health problem of the modern world, is a threat to all mankind. Essential hypertension is most common (88%) among hypertensives.¹ Early detection of proneness to hypertension may enable an individual to enjoy a healthy life by altering the lifestyle (e.g. avoidance of alcoholic drinks, smoking, excessive

fatty food intake, etc. and adoption of the practice of yogic exercise,² moderate aerobic exercise,³ mental relaxation,⁴ etc.). Therefore, if a person can be informed that he may suffer from hypertension well in advance of the onset of hypertension, it will be obviously beneficial.

In neurogenic hypertension, cardio-vascular reactivity to stress may have a pathological role. Reports support the notion that individuals at high risk of hypertension may

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have an exaggerated stress-induced cardiovascular response at a younger age.⁵ The sympathetic nervous system plays a prime role in the pathogenesis of essential hypertension. Subjects with a positive history of familial hypertension, high resting heart rate, or transient increase in arterial hypertension are reported to have revealed blood pressure hyper-responsiveness to stress stimuli mediated by an over-activity of the sympathetic nervous system.⁶

After being stimulated by a stressor, the sympathetic system triggers a rise in heart rate and blood pressure; nevertheless, heart rate and blood pressure usually tend to return to normal levels within a very short period of time after the withdrawal of the stressor.⁷ Elevated blood pressure and heart rate prevail for a longer time in the susceptible individual. Naturally, the persons presenting higher cardiovascular reactivity to a stressor and slower rate of recovery after the withdrawal of the stressor causing the sympathetic stimulation may be at a high risk of developing hypertension in their future life. The present study was designed to explore the cardiovascular reactivity to stress (cold stress) and the recovery time after the withdrawal of the stressor in normotensive young adults.

Methods

Normotensive, non-smoking healthy sedentary male students and staff of Nepal Medical College (n=50, age group 18-35 years) participated in the study, conducted between May 2008 and June 2008. Ethical approval was granted by the institutional review board, and informed consent was obtained from the volunteers. The blood pressure of each subject was recorded using a mercury sphygmomanometer. The casual blood pressure and heart rate of the normotensive subjects were recorded after allowing the subject to rest in an easy-chair for five minutes. Systolic pressure was determined at the point when the Korotkoff sound became audible, and diastolic pressure was measured at the point at which the sound disappeared.^{8,9} Blood pressure was measured between 10:00 and 11:00 AM when the room temperature was 16-18°C.

Each volunteer was asked whether or not his parents,

either or both, were currently on antihypertensive drugs and whether or not they were diabetic. Volunteers whose parents were non-diabetic, hypertensive, or normotensive were included in the study. Participants either of whose parents was reported hypertensive were considered volunteers from hypertensive families. Among the study population (Nepalese population of the said age group) the normal blood pressure among the males was found to be around 118/73 mmHg¹⁰ and blood pressure more than 140/90 mmHg was regarded as hypertension.⁹

First, heart rate and blood pressure were recorded from the left hand. The sphygmomanometer cuff was kept in situ for the next measurement of blood pressure. The right hand of the subject was immersed in a mixture of ice and water (4°C) for 1 minute (Cold pressor test). At the completion of the one minute, blood pressure and heart rate were measured and the subject was asked to remove his hand from the cold water.¹¹ The subject's hand was thereafter wrapped up in a warm towel for 3 minutes, and he was allowed to rest. Five minutes after the cold pressor test, heart rate and blood pressure were noted once more (recovery).

Statistical analysis

The changes in blood pressure and heart rate amongst the normotensive volunteers of the hypertensive and normotensive families were compared using Student's t-test.

Results

The results are presented in Table 1, which demonstrates that the cold pressor test for a minute elevated both systolic and diastolic pressures. Although 5 minutes after the withdrawal of the stimulus, blood pressure, both systolic and diastolic, approached the baseline, it was- as was the case before the test- in the volunteers from the non-hypertensive families (n=25). On the other hand, in the case of the normotensive volunteers from the hypertensive families (n=25), diastolic blood pressure remained elevated (p<0.05) and did not

Table 1. Base line, stress and recovery heart rate and blood pressure in normotensive and hypertensive families*

Volunteers	Conditions	HR	SBP (mmHg)	DBP (mmHg)	MP (mmHg)
Normotensive Family (n=25)	Baseline	74.28±10.56	112.24±10.05	71.04±9.86	84.77±9.24
	4°C exposure	74.76±10.38	118.72±10.21**	75.05±10.01	89.59±9.42
	Recovery	73.92±10.00	112.96±9.34	71.52±9.47	85.33±8.87
Hypertensive Family (n=25)	Baseline	75.80±14.22	115.32±10.20	72.16±7.13	86.56±7.49
	4°C exposure	76.28±12.15	122.64±10.84**	83.04±8.60**	96.18±8.47**
	Recovery	75.84±11.31	115.68±9.80	78.16±7.95**	90.68±7.99

*Data are presented as mean±SD

**P<0.05

HR, Heart rate; SBP, Systolic blood pressure; DBP, Diastolic blood pressure; MP, Mean pressure



return to the baseline following the aforesaid experimental condition.

Discussion

Stimulation of the sympathetic noradrenergic fibers causes vasoconstriction. The noradrenergic post-ganglionic sympathetic nerves also contain neuropeptide Y, a vasoconstrictor. Vasoconstrictor discharge is associated with increased arteriolar constriction and a rise in blood pressure. Impulses in nor-adrenergic sympathetic nerves beget an increase in the heart rate and the force of cardiac contraction.^{1,12}

Once stimulated by a stressor, the sympathetic system sets off a rise in heart rate and blood pressure, but usually these effects return to normal levels within a very short period of time (5 minutes) after the withdrawal of the stressor.⁷ In persons who show higher cardiovascular reactivity to a stressor and slower rate of recovery after the withdrawal of the stressor responsible for sympathetic stimulation, the autonomic control system is not competent enough to lower heart rate and blood pressure to the baseline quickly. Naturally, this group of individuals is at high risk of an early onset of hypertension in the future.

Immersion of the right hand up to the wrist in 4°C cold water stressed the subjects through cold sensation and pain.¹³ Stress exerted through the cold pressor test for a minute stimulated the sympathetic nervous system and produced an acceleration of the heart rate and rise in blood pressure, both systolic and diastolic, in comparison to those recorded before the foregoing test in all the normotensive volunteers. In the case of the offspring of the hypertensive adults, the elevation of diastolic pressure was so pronounced that the mean blood pressure increased significantly, in comparison to the baseline mean pressure. This finding corroborates the previous finding that the children of hypertensive parents show more blood pressure responsiveness to stress.¹⁴

Five minutes after the removal of the hand from the cold water, the sympathetic stimulation through cold and pain was withdrawn and blood pressure and heart rate approached the baseline level in all the volunteers from the non-hypertensive families. Nevertheless, in almost all the volunteers whose parents, either or both, were reported to be hypertensive, diastolic blood pressure did not return to the normal level even 5 minutes after the withdrawal of the stimulus. Diastolic blood pressure is the index of peripheral resistance.¹⁵ Higher diastolic pressure even 5 minutes after the withdrawal of the cold stimulus indicated that once constricted through sympathetic stimulation, vessels took longer to return to their normal original diameters in the case of those subjects. Hypertension has familial disposition. The subjects from the hypertensive families (based on the information from the volunteers, whose parents- either or

both- were hypertensive) showed greater and prolonged responsiveness to sympathetic stimulation in comparison to the subjects from the non-hypertensive families, indicating the hyper responsiveness of the sympathetic nervous system to stressor stimuli in the offspring of hypertensive adults.

Conclusion

It could be concluded that individuals who show greater and specially prolonged responsiveness to diastolic blood pressure due to sympathetic stimulation through the cold pressor test will be at a high risk of an early onset of hypertension in the future.

Acknowledgement

Authors are grateful to Professor Suraj Shakya, HOD, Department of Ophthalmology and Dr. Shekhar Babu Rizyal, Principal, Nepal Medical College for their active cooperation and support. Thanks are also due to Nepal Medical College Research Committee for the funding of this research.

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