

CARDIOVASCULAR REACTIVITY TO STRESS SHOWS PRONENESS TO FUTURE BLOOD PRESSURE STATUS IN STUDENTS OF A TEACHING HOSPITAL IN NEPAL

Smriti Singh,¹ Rajan Pandit,¹ Barsika Katwal²

¹Department of Physiology and ²Department of Forensic Medicine, Nepal Medical College and Teaching Hospital (NMCTH), Attarkhel, Gokarneshwor-8, Kathmandu, Nepal

ABSTRACT

Stress is a condition that disrupts or threatens to disrupt homeostasis. Stress may be physical or mental. Physical stress includes exercise (isometric or isotonic), pain, temperature (too hot or cold) etc. The development of hypertension is usually preceded by a prehypertensive state that may be manifested by abnormal cardiovascular reactivity to different types of stress viz., mental stress, cold water immersion, isotonic exercise, isometric handgrip, and valsalva maneuver. In present study, we have used isometric handgrip (IHG) exercise, as a stressor, aiming to identify individuals at increased risk for developing hypertension at early life. Normotensive, non-smoker sedentary two hundred male subjects, one hundred each from normotensive and hypertensive families, of age group 18-25 years participated in the study as volunteers. The causal blood pressure and heart rate of the participants were recorded in the sitting position by using mercury sphygmomanometer and stethoscope. Then, the isometric handgrip (IHG) exercise demonstrated to each of them using handgrip dynamometer. Maximum voluntary contraction (MVC) was noted as maximum pressure (in Kg) sustained during three seconds of handgrip using a handgrip dynamometer. The participants were asked to sustain isometric handgrip at one third of MVC for one minute with the same instrument (handgrip dynamometer). Both blood pressure and heart rate were recorded immediately after 1 and 3 minutes following isometric handgrip (IHG) exercise. The data analyzed using t-test showed that diastolic blood pressure didn't return and stabilized to pre-exercise level even after 3 minutes following exercise in volunteers who were mostly from hypertensive family. More number of volunteers with family history of hypertensive (24%) showed elevated diastolic blood pressure even after 3 minutes whereas a few of the volunteers (8%) with no family history of hypertension showed rise in DBP even after 3 minutes following isometric handgrip (IHG) exercise. This present study indicated that the individuals having family history of hypertension are prone to develop hypertension in their early life, therefore, must adopt the healthier life style like avoidance of alcohol, smoking, and practice yogic exercise.

KEYWORDS

Cardiovascular, blood pressure, hand grip, isometric, stress

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CORRESPONDING AUTHOR

Dr. Smriti Singh
Assistant Professor,
Department of Physiology,
Nepal Medical College Teaching Hospital,
Attarkhel, Gokarneshwor-8, Kathmandu, Nepal
Email: smsengh@gmail.com
Orcid No: <https://orcid.org/0000-0001-7169-2188>
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INTRODUCTION

Autonomic nervous system (ANS) or visceral nervous system controls and regulates vital systems like cardiovascular system, respiratory system, digestive system, and others. One of the utmost components to maintain internal environment of the body, homeostasis, is ANS. Stress is a condition that disrupts or threatens to disrupt homeostasis. Stress may be physical or mental. Physical stress includes exercise (isometric or isotonic), pain, temperature (too hot or too cold), etc. Stress is associated with liberation of glucocorticoids and catecholamines along with other hormones.¹

Stressor like hand immersion in cold (4°C) water or isometric exercise by handgrip dynamometer, and full knee extension horizontally increased in blood pressure, which decreases and stabilizes to casual/baseline blood pressure within few minutes following completion of exercise.¹⁻³ However, people who

1 minute and 3 minutes following isometric handgrip (IHG) exercise, a stressor that causes isometric contraction of muscles that elicit sympathetic stimulation, among individuals from normotensive and hypertensive families.

MATERIALS AND METHODS

After obtaining ethical approval from the Institutional Review Committee of Nepal Medical College and Teaching Hospital (Ref: 033-076/077) and written consent from the participants, the present study was carried out in Department of Clinical Physiology, Nepal Medical College and Teaching Hospital. The experiment was done at 10-11 AM, from January 2021 to April 2021, and the room temperature was maintained at 20-22°C.

Normotensive, non-smoker sedentary two hundred male subjects, one hundred each from normotensive and hypertensive families, of age group 18-25 years participated in the study as



Fig. 1: Demonstrating isometric contraction of hand muscles (one third of maximum voluntary isometric contraction)

are at risk for elevated blood pressure in near future might have overstated stress persuaded cardiovascular responses.⁴ The development of hypertension is usually preceded by a prehypertensive state that may be manifested by abnormal cardiovascular reactivity to different types of stress viz., mental stress, cold water immersion, isotonic exercise, isometric handgrip, and valsalva maneuver.⁵

This present study, therefore, was carried out with an aim to identify individuals at increased risk for developing hypertension. For this purpose, we observed the heart rate and blood pressure immediately after

volunteers. The volunteers were requested to abstain from beverages like tea, and coffee for preferably 12 hours and strenuous physical activity and alcohol for at least a day prior to maneuver.

Blood pressure was measured in the sitting position by using mercury sphygmomanometer and stethoscope. The causal blood pressure and heart rate of the normotensive participants were recorded after allowing them to take rest for five minutes. Then, the isometric handgrip (IHG) exercise demonstrated to each of them using handgrip dynamometer. Maximum voluntary contraction (MVC) was noted as

maximum pressure (in Kg) sustained during three seconds of handgrip using a handgrip dynamometer. The participants were asked to sustain isometric handgrip at one third of MVC for one minute with the same instrument (handgrip dynamometer) (Fig. 1).

At the completion of isometric exercise, the subject was allowed to relax. Both heart rate and blood pressure were measured immediately on completion of one minute and three minutes following isometric handgrip exercise. Systolic blood pressure was noted at the point where

RESULTS

Table 1 and 2 depict resting, immediately after 1 minute and 3 minutes following isometric handgrip (IHG) exercise of heart rate, blood pressure in volunteers from normotensive and hypertensive families respectively. Table 1, the majority of volunteers, ninety percent and Table 2, seventy-six percent, of volunteers showed rise in heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) after one minute following IHG and

Table 1: Heart rate, blood pressure in volunteers from normotensive families

Volunteers from normotensive family	Condition	Heart rate (HR) Mean±SD	Systolic blood pressure (SBP) Mean±SD	Diastolic blood pressure (DBP) Mean±SD
n = 90	Baseline	70.20±2.61	104.98±2.13	71.23±2.14
	After 1 minute	77.02±7.23*	113.29±9.19*	78.51±1.29*
	After 3 minutes	69.02±9.12	105.12±3.24	71.12±4.36
n = 8	Baseline	78.12±2.31	119.91±2.10	78.19±5.18
	After 1 minute	86.23±1.24*	125.23±2.18*	85.34±2.36*
	After 3 minutes	77.94±4.21	120.12±3.12	84.67±1.23*

*P<0.05, HR= Heart rate, SBP=Systolic blood pressure, DBP= Diastolic blood pressure,SD: Standard deviation

Table 2: Heart rate, Blood Pressure in volunteers from hypertensive families

Volunteers from hypertensive family	Condition	Heart rate (HR) Mean±SD	Systolic blood pressure (SBP) Mean±SD	Diastolic blood pressure (DBP) Mean±SD
n = 76	Resting	71.39±1.9	113.22±6.22	72.91±2.39
	After 1 minute	78.11±4.28*	118.45±2.50*	77.89±1.23*
	After 3 minutes	71.62±3.90	112.98±4.14	72.18±1.58
n = 24	Resting	79.49±5.20	120.22±1.23	80.72±3.98
	After 1 minute	86.35±4.14*	127.21±4.24*	86.15±3.29*
	After 3 minutes	79.23±1.23	120.80±1.40	85.12±23.44*

*P<0.05,HR= Heart rate, SBP=Systolic blood pressure, DBP= Diastolic blood pressure,SD: Standard deviation

Korotkoff sound became audible and diastolic blood pressure was noted at the point where the sound muffled.^{6,7} Two of the volunteers did not participate as they decided to leave their studies here. All the collected data were compiled and entered in Microsoft Excel and then analyzed by SPSS-21 by using student t- test.

the same above said parameters among those volunteers stabilized to baseline after 3 minutes following IHG. However, a few volunteers (8%) with no family history of hypertension showed elevated DBP even after 3 minutes following IHG (Table 1). On the other hand, more number of volunteers from hypertensive family (24%), in Table 2, showed elevated DBP, which did not return to baseline and stabilize following the

aforesaid experimental condition, even after 3 minutes ($P < 0.05$).

DISCUSSION

Only young male volunteers of age 18-25 years were included in this study, isometric handgrip (IHG) exercise, because estrogen effects prevail in child bearing age in female plus they have lower autonomic support of arterial BP and lesser effective baroreflex buffering than men.⁸

IHG exercise using handgrip dynamometer was performed by two hundred participants, hundred each from family with and without history of hypertension. At first, maximum voluntary contraction (MVC) was noted as maximum pressure (in Kg) sustained during three seconds of handgrip using a handgrip dynamometer. Then, the participants were asked to sustain isometric handgrip at one third of MVC for one minute with the same instrument (handgrip dynamometer). During this maneuver, blood pressure and heart rate were measured immediately after 1 minute and the same parameters were recorded again after 3 minutes.

In the present study, comparisons of baseline systolic and diastolic blood pressure, heart rate were done immediately after 1 minute and again after 3 minutes following IHG. We noted statistically significant value of blood pressures and heart rate immediately after 1-minute exercise in all participants, $P < 0.05$. Moreover, we also recorded statistically insignificant value of heart rate and systolic blood pressure among all participants after 3 minutes.

More number of volunteers with family history of hypertension (24%) showed elevated diastolic blood pressure even after 3 minutes whereas a few of the volunteers (8%) with no family history of hypertension showed rise in DBP even after 3 minutes following IHG exercise. This is in accordance with the observation of Kotchen - "Family studies controlling for a common environment indicate the blood pressure heritability are in the range of 15-35%."⁹

Sympathetic nervous system is stimulated by two ways while performing isometric exercises. The first one is pressor reflex which originates in contractile muscle.^{10,11} The reflex starts in sensory receptors sensitive to ischemic metabolites which are produced during contraction of muscles. The second one is to increase sympathetic discharge by stimulation of cardiovascular centers which are involved in initiation of somatomotor activity by descending

central neural pathways.^{12,13} Furthermore, studies have revealed that increase in BP by chemoreflex is not as much as observed in static contraction¹⁴⁻¹⁶ while attempting to contract muscles already paralyzed by local anesthesia or neuromuscular blocking agent; however the role of central command contributed major role to increase in both heart rate and blood pressure.^{17,18} Marked increase in vasoconstrictor sympathetic nerve activity in isometric exercise results in increased peripheral resistance and diastolic blood pressure.^{15,19} Similarly, the vagal extraction promotes increase in HR and cardiac output causing rise in BP especially the systolic blood pressure.²⁰⁻²² These myriad physiological responses to stress in the form of handgrip exercise, therefore, explain an increase in blood pressures, heart rate immediately after 1 minute. Moreover, catecholamines have half-life of about 2 minutes in circulation.^{23,24} Naturally, person having good autonomic control could bring down and stabilize blood pressure to pre-exercise state quickly about 3 minutes after the stressor.

Quick stabilization of DBP to the baseline or even below within 3 minutes indicates competent vagal activation through baroreflex and the normal sympathetic discharge to the peripheral blood vessels. On the contrary, persistence of diastolic blood pressure at a higher level for more than three minutes indicates either the incompetent vagal stimulation or overactive sympathetic system resulting in peripheral arteriolar constriction through liberation of more catecholamines from nerves and from adrenal medulla²³ or less production of nitric oxide from endothelium of blood vessels.²⁵

We found a few percent of the volunteers (8%) with no family history of hypertension and more percent of volunteers with family history of hypertension (24%) could not quickly stabilize the diastolic blood pressure, suggesting that they have incompetent vagal stimulation or over activation of sympathetic system or less nitric oxide production from endothelium of their blood vessels. Besides, the early onset of hypertension is 3 times more in individuals with family history of hypertension as compared with individuals without family history of hypertension. Our study finding also align with the previous study done by Pandit *et al*¹ among Nepalese of age group 18-25 years, where a simple maneuver full knee extension horizontally (FKEH) has been introduced as a stressor that caused full isometric contraction of quadriceps femoris muscles of both sides. Authors found more number of volunteers with family history of hypertensive (30%) elevated value of diastolic blood pressure even after 3

minutes following FKEH, but we noted only in 24% volunteers. In contrast, we found more number of volunteers without family history of hypertension (8%) having higher value of diastolic blood pressure, but they noted only in 5% volunteers.

This present coupled with other previous studies indicated that the individuals having family

history of hypertension are prone to develop hypertension in their early life, therefore, must adopt the healthier life style like avoidance of alcohol, smoking, and practice yogic exercise to avoid early onset of hypertension.

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