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RESEARCH ARTICLE

Cardiovascular reactivity to mental and physical stress in offspring of hypertensive parents

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ABSTRACT

Background: Exaggerated cardiovascular reactivity to stressful stimuli is a risk factor for the development of hypertension. The genetic influence on blood pressure (BP) reactivity to stress and its control mechanisms has been receiving considerable support. **Aim and Objective:** The study aims at comparing the reactivity scores of mental arithmetic stress test and cold pressor test (ΔMAST, ΔCPT) in offspring with and without genetic predisposition to hypertension. **Materials and Methods:** The study was conducted on 40 medical students with diagnosed hypertensive parents and an equal number of age- and sex-matched healthy controls aged 17–20 years. Each subject was exposed to two different stress tests on 2 successive days. Cardiovascular parameters: BP – systolic BP (SBP) and diastolic BP, pulse rate, pulse pressure, and mean arterial pressure and rate pressure product were calculated before, during. and after the test. The reactivity scores were analyzed using independent *t*-test or Mann–Whitney test. $P < 0.05$ was considered as statistically significant. **Results:** Offspring of hypertensive parents had significantly higher SBP (139.0 ± 1.4 and 120.93 ± 1.6 mmHg) and increased reactivity score to MAST (18.1 ± 0.84 and 14.62 ± 1.4 mmHg), but not to CPT (12.82 ± 0.64 and 11.64 ± 1.32 mmHg) than offspring of normotensive parents. **Conclusion:** Our study showed relative exaggerated cardiovascular reactivity to mental stress (MAST) compared to physical stress (CPT).

KEY WORDS: Stress Reactivity; Cold Pressor; Mental Stress

INTRODUCTION

Cardiovascular reactivity to stress is defined as an exaggerated cardiovascular response to a behavioral, physical, or psychological challenge. Studies show a strong association between raised cardiovascular reactivity and future hypertension. The American Psychological Association has provided evidence that 20% of population report extensive stress and 80% say their stress levels increased over past years (APA, 2014).[1]

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Cardiovascular reactivity research examines the alterations in reactivity that occurs in response to environmental circumstances considered to be stressful. Stress either psychological or physical will stimulate the sympathetic nervous system. Psychological stress exhibits a beta-adrenergic response with increase in heart rate and cardiac output, where as physical stress like cold pressor test (CPT) induces an alpha-adrenergic mediated vasoconstriction with an increase in total peripheral resistance.[2-4]

Stress leads to increased sympathetic activity and increased hypothalamic-pituitary-adrenal axis activity. Following which there is increased inflammation and more oxidative stress which eventually results in reduced artery flow dilation. Moreover, physical inactivity enhances the above mechanism which ultimately poses an increased risk for cardiovascular

disease. Sympathovagal imbalance is a potential risk factor for adverse cardiovascular events.[4-6]

Thus, exaggerated cardiovascular reactivity to stress resulting in increase in blood pressure (BP) due to impaired autonomic control of heart rate and cardiac function needs to be studied for early detection of hypertension in offspring of hypertensive parents.

The previous studies in this field had been done mostly in hypertensive subjects to assess stress reactivity while studies in offspring of hypertensive subjects are very few. Hardly any study been done to compare the cardiovascular reactivity between mental stress and physical stress.[2-7]

Aims and Objectives

The aim of the study was to study and compare the reactivity scores of Mental Arithmetic stress task and CPT (ΔMAST and ΔCPT) in offspring with and without genetic predisposition to hypertension.

MATERIALS AND METHODS

The study was conducted in the Department of Physiology, Maulana Azad Medical College, New Delhi. The study was conducted after institutional ethical committee approval and informed consent from the parents.

Study Population

- 40 offspring aged 17–20 years of diagnosed hypertensive parents were considered as study subjects
- 40 offspring of normotensive parents were considered as controls.

Subject Selection

- Offspring aged 15–18 years with normal BMI (19–25 kg/m^2)
- At least one of the parents was hypertensive.

Exclusion Criteria

The following criteria are as follows:

- Children with any comorbid conditions such as hypertension, diabetes mellitus, bronchial asthma, hypothyroidism, hyperthyroidism, ant renal disease, and any endocrine disorder
- Children under medication
- Children with a habit of smoking or tobacco chewing
- Any recent history of illness to be excluded.

Methods

Prerequisites before doing stress tests

- The subjects should have abstained from tea, coffee, and ice cream at least 12 h before testing
- Subjects should have been relaxed and comfortable
- Resting BP and heart rate (baseline) were measured at ambient temperature using mercury sphygmomanometer
- Each subject was exposed to two different stress tests on 2 successive days
- Cardiovascular parameters:
  1. BP – systolic BP (SBP) and diastolic BP (DBP) were measured by using mercury sphygmomanometer
  2. Pulse rate was measured clinically using three finger method on radial artery
  3. Pulse pressure was calculated by subtracting SBP with DBP (SBP-DBP)
  4. Mean arterial pressure was calculated by the formula MAP= DBP+ 1/3PP
  5. Rate pressure product (RPP) was calculated by using formula RPP=(SBP*PR)/100.

Provocative Tests

Mental arithmetic stress task (MAST) on day 1

The subject took rest in a sitting position for at least 5 min. At the end of this, cardiovascular parameters were measured for at least 3 times. The two closest measurements were done average. Then, the subject was asked to subtract 11 from 1079 continuously as quickly as possible for 3 min. Mistakes in between if any were corrected. BP and heart rate were measured at 2nd min. Reactivity scores (ΔMAST) were calculated of each parameter by subtracting the stress test values from the baseline values. Following the test, the subject was asked to take rest for another 2 min and cardiovascular parameters were measured again.

CPT on day 2

The subject was asked to follow the same protocol of MAST before starting the test. Then, the subject was asked to immerse his/her hand in ice cold water 4°C for 1 min or till he perceived the pain. At the end of 1 and 5 min, heart rate and BP measurements were taken Reactivity score (ΔCPT) were calculated.

Mean ± standard deviation was used to summarize the data. Independent *t*-test was used to compare data. $P < 0.05$ was considered as the statistical significance level.

RESULTS

There were no significant differences in age, body mass index between normotensive young adults with and without family history of hypertension (FHoH). Normotensive young adults with FHoH had significantly higher SBP than normotensive young adults without FHoH ($P = 0.02$). However, normotensive young adults with and without FHoH did not differ significantly in DBP. Normotensive offspring with FHoH exerted greater cardiovascular reactivity to

MAST compared to offspring without FHOH. Differences in SBP, DBP, PR, MABP, and RPP reactivity to CPT were observed between normotensive offspring with and without genetic predisposition to hypertension, but not significant [Tables 1-3 and Figures 1 and 2].

DISCUSSION

Results found normotensive offspring with FHOH have exaggerated reactivity to MAST but not to CPT.

The above findings are in accordance with previous few studies where they have described that MAST and CPT differ in mechanism to stimulate cardiovascular response. MAST – an active task, cardiac stimulator, the mental load, promotes a rise in plasma epinephrine and elicits a rise in BP through a rise in cardiac output. CPT – vascular stimulator which raises the norepinephrine level, that promotes a pressor response through a rise in total peripheral resistance.[8-12]

It is unclear why subjects shown increased DBP reactivity. Baroreflex dysfunction may contribute the disturbance of vascular autoregulation, serving as another explanation for the exaggerated DBP reactivity, to be verified with further studies.

Table 1: Characteristics of subjects stratified by FHoH

Characteristics	No FHoH (mean±SD)	Family history of hypertension (mean±SD)
Age (years)	18±0.4	18±0.2
BMI	21.19±0.4	21.6±0.4
SBP (mmHg)	103±1.6	108±1.2*
DBP (mmHg)	60±0.4	67.4±1.2

**P*<0.05, significant, DBP: Diastolic blood pressure, SBP: Systolic blood pressure, FHoH: Family history of hypertension

Table 2: Delta change score of cardiovascular reactivity to MAST

Characteristics	No FHoH (mean±SD)	FHoH (mean±SD)
SBP (mmHg)	16.5±1.4	20.6 ± 0.6*
DBP (mmHg)	12.6±0.5	16.8±0.4*
PR (beats/min)	8.75 ± 0.4	9.25±0.8

**P*<0.05, significant. DBP: Diastolic blood pressure, SBP: Systolic blood pressure, FHoH: Family history of hypertension

Table 3: Delta change score of cardiovascular reactivity to CPT

Characteristics	No FHoH (mean±SD)	FHoH (mean±SD)
SBP (mmHg)	22.84±1.6	24.72±0.8
DBP (mmHg)	21.4±1.2	23.14±1.32
PR (beats/min)	1.25±2.2	3.25±1.6

DBP: Diastolic blood pressure, SBP: Systolic blood pressure, FHoH: Family history of hypertension

As conclusion, normotensive young adults with FHoH had exaggerated cardiovascular reactivity to mental but not to physical test.[13-15]

Strength of the Study

Future trials should evaluate the prognostic impact of interventions targeting the behavioral aspects of stress reactivity. More accurate methods of assessment of sympathetic activity such as estimation of plasma catecholamines or metabolites of catecholamines in urine such as vanillylmandelic acid, metanephrine, and normetanephrine to be done. Effect of physical activity on cardiovascular reactivity, which will not only reduce the immediate effects of stress but enhance the recovery from stressors, should be studied.

Limitations of the Study

For MAST, literate subjects were selected only and socioeconomic strata of the subjects were not taken into account which could have led to a minimal bias in the study.

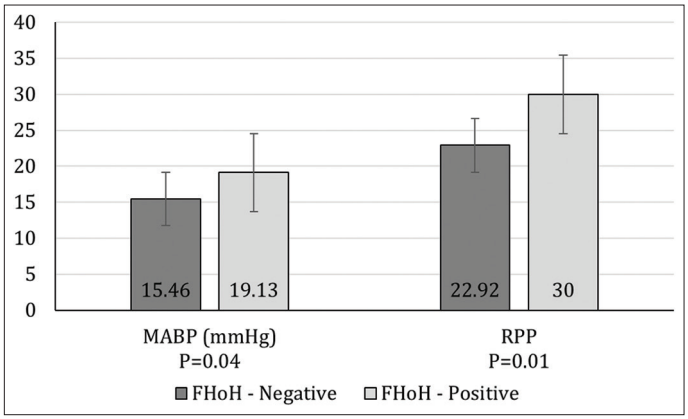

Figure 1: Delta change score of cardiovascular reactivity to mental arithmetic stress task (MAST) (FHoH: Family history of Hypertension MABP: Mean arterial blood pressure; RPP: Rate pressure product)

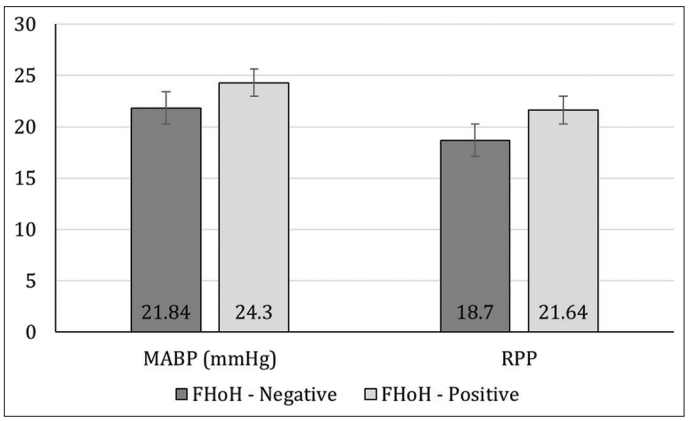

Figure 2: Delta change score of cardiovascular reactivity to cold pressor test (FHoH: Family history of Hypertension MABP: Mean arterial blood pressure; RPP: Rate pressure product)

CONCLUSION

CPT has been used for the diagnosis of cardiovascular reactivity in many studies; however, the significant differences in the cardiovascular reactivity to MAST could have potential implication in identification of normotensive candidates at future risk of suffering from hypertensive disease.

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