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Original Article

# Effect of Laboratory Stressor on Arterial Compliance in Young Women

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## Abstract

**Introduction:** Coronary Heart Disease (CHD) is lower in women in comparison to male which is attributed to the effect of estrogen on vascular system. However, report on estrogen replacement therapy in menopausal women on blood pressure reactivity is inconsistent. The psychosocial stressors of daily life trigger elevated sympathetic response which is an important independent cardiovascular risk factor. Therefore, the present study intends to determine the effect of laboratory stressor on arterial compliance in young women during different phases of menstrual cycle.

**Methods:** It is a cross-sectional, observational study conducted on 24 students of 18-22 years of age group. The participants attended two sessions in late follicular (days 12-15) and luteal phase (days 21-24). The anthropometric parameters and detailed menstrual history were recorded. They were exposed to a 5-min Mental Arithmetic Stress Test (MAST). Peripheral SBP, DBP, central SBP, DBP, Heart rate (HR), Augmentation Index, and brachial ankle pulse wave velocity (baPWV) were recorded before and during the test. Paired t test was performed to compare the means of the parameters and linear regression analysis was done to examine the association between cardiovascular parameters and MAST score in both phases. ANCOVA was done to examine the difference in MAST response between follicular and luteal phases.

**Results:** BMI and WHR of the subjects were mostly within normal limits with few exceptions. Heart rate was significantly decreased during MAST in follicular phase. However, baPWV was increased significantly during MAST in both phases. There was an increasing trend in other parameters during MAST in both phases excepting pulse pressure. No association between cardiovascular parameters and MAST score was revealed by linear regression analysis. There was no significant difference in MAST score in both phases.

**Conclusions:** An increasing trend of cardiovascular parameters during MAST was observed because of elevated sympathetic activity. A decrease in HR was observed in certain participants during both phases while performing MAST. This decline in peripheral vascular response may enhance the risk of major cardiovascular events in future. This study therefore concludes that the effect of laboratory stressor in the form of Mental Arithmetic Stress Test (MAST) superimposed on the effect of ovarian hormones, decreases arterial compliance as measured indirectly by baPWV.

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# Introduction

The incidence of coronary heart disease (CHD) is lower in women at all ages in comparison to male and it increases after menopause (1). Apparently estrogen provides this protection as evidenced by cyclical variation of plasma lipid levelsand its effect on vessel physiology (2-4). However, there is inconsistent report regarding action of estrogen replacement therapy in menopausal women on blood pressure reactivity (5).

The modern life style is associated with encountering innumerable number of stressors. These psychosocial stressors of daily life trigger emotion which is an important independent risk factor in the development and progression of cardiovascular disease (CVD), especially in women (6). Interestingly, ovarian steroids itself are responsible for psychological changes observed during different phases of menstrual cycle. The luteal phase is more associated with increased subjective experience of personal stress, more intense negative mood and deterioration of cognitive function (7). On the other hand, estrogen may moderate psychological reaction during stress (8).

Arterial stiffness is now considered a causative factor for hypertension. It is plausible that psychological stress may contribute to arterial stiffness before hypertension is manifested (9). Many prospective studies examined the hemodynamic reactions to laboratory stress tests and CVD in Western countries. However, relatively little is known about cardiovascular reactivity in Asian populations (10). Therefore, it is prudent to explore the effect of laboratory stressor on arterial compliance in women during different phases of menstrual cycle, knowing that arterial compliance is an independent indicator of cardiovascular morbidity and mortality.

#### Subjects

It is a cross sectional, observational study performed during July and August 2018 on a sample size of 30 young women. As per the inclusion and exclusion criteria, young women of age group of 18-35 year,having stable menstrual cycle for at least last 2 months and with no history of chronic systemic illness or any peripheral vascular disease, were recruited in the present study.

#### Protocol

Each participant attended two laboratory sessions, one during late follicular phase (days 12-15) and the other in luteal phase (days 21-24) in between 4-7 PM. Phases were determined by taking menstrual history. Before procedure, an informed consent was obtained from the participants and a data collection form was used to record subject's anthropometric measurements such as height, weight, BMI, waist-hip ratio and detailed menstrual history. Physiological parameters such as peripheral (brachial artery) DBP, SBP, MBP, PP, Central BP and augmentation index were measured by using USCOM make BP+(cardioscope II), Australia. After 5 min rest, brachial ankle pulse wave velocity (baPWV) of the subject was recorded. Following this, the participants were asked to perform mental arithmetic stress test (MAST) involving subtraction of two-digit numbers presented in series on cards for 5 min as reported earlierand during this period baPWV was also recorded (5). For recording of baPWV, Pulse waveform of brachial artery and posterior tibial artery were recorded simultaneously with pulse transducers for 5 min (AD Instruments, Australia). The sample acquisition frequency was set at 1,000 Hz. The components over 5 Hz were stored using a pass lter and the wave front was determined. The time interval between the wave front of brachial and ankle waveform is designated as $\Delta$Tba. The distance between sampling points of baPWV was calculated as follows:

$$baPWV = (La - Lb) / \Delta Tba$$

where, Lb = [0.2195 × suprasternal notch to brachium (in cm) – 2.0734 and La = [0.8129 × suprasternal notch to ankle (in cm) + 12.328] (11).

#### Statistical analysis

Normality of data and homogeneity of variance was tested using Shapiro-Wilk's test and Levene's test respectively. The data has been presented as Mean±Standard deviation. Paired t test was employed for comparison of means of the variables before and during MAST in both phases. Paired t test was also applied to comparemean change (change of variable before and during MAST) in variables in both phases.Pearson correlation was employed to determine correlation among various cardiovascular parameters. Linear regression analysis was performed to examine the association of various physiological cardiovascular parameters and its mean changes with MAST score in both phases. ANCOVA was done to examine the difference in MAST response between follicular and luteal phases. Statistical analysis has been done by SPSS 20 version. (SPSS, IBM Inc., Chicago, IL). A two-tailed P value less than 0.05 has been taken as the cut off level of significance.

## Results

Basic characteristics of the participants were shown in table 1. Mostly the subjects were of 18-22 years. Few subjects were overweight as per WHO Asian criteria [BMI: 23-27.5 (overweight)]. Waist Hip ratio (WHR) of the subjects was within normal range.

It is evident from table 2,HR was significantly decreased (P=0.048) during MAST in follicular phase. However, baPWV was increased significantly during MAST in both phases. An increasing trend in other parameters was observed during MAST in both phases excepting pulse pressure, though it was not statistically significant.

No significant correlation was found between baPWV and other cardiovascular parameters.Linear regression analysis also revealed no significant association of various physiological cardiovascular parameters and its mean changes with MAST score in both phases.There was no significant difference in MAST score during late follicular and luteal phases of menstrual cycle.

## Discussion

The present study aimed at understanding the effect of laboratory stressor in the form of Mental Arithmetic Stress Test (MAST) superimposed on the effect of ovarian hormones, which vary in their levels cyclically, on arterial compliance. It documents an increasing trend of peripheral SBP and DBP, MAP, central SBP and DBP, and augmentation index during

TABLE I: Basic characteristics of the participants.

| *Age (Mean±SD)* | *Height (cm) (Mean±SD)* | *Weight (kg) (Mean±SD)* | *BMI (kg/m²) (Mean±SD)* | *Waist Hip ratio (WHR) (Mean±SD)* |
|---|---|---|---|---|
| 20.75±2.55 | 158.45±6.54 | 58.29±9.77 | 23.26±3.91 | 0.72±0.05 |

TABLE II: Comparison of means of various physiological variables before and during MAST.

| *Variables* | *Phase* | | | | | |
|---|---|---|---|---|---|---|
| | *Follicular* | | | *Luteal* | | |
| | *Before MAST (Mean±SD)* | *During MAST (Mean±SD)* | *Mean change±SD* | *Before MAST (Mean±SD)* | *During MAST (Mean±SD)* | *Mean change±SD* |
| Peripheral SBP (mm Hg) | 107.38±7.37 | 108.08±8.21 | 0.71±5.68 | 104.96±7.98 | 106.38±7.84 | 1.42±6.77 |
| Peripheral DBP (mm Hg) | 62.42±5.44 | 63.33±6.78 | 0.92±5.53 | 60.58±6.31 | 62.38±4.81 | 1.79±4.86 |
| PP (mm Hg) | 44.96±4.58 | 44.75±5.29 | 0.21±5.19 | 44.38±5.27 | 44.00±5.67 | 0.71±4.89 |
| MAP (mm Hg) | 77.25±5.75 | 78.10±6.84 | 0.85±5.02 | 75.22±6.45 | 76.89±5.35 | 1.67±5.06 |
| Heart Rate (bpm) | 75.71±11.05* | 72.58±9.40 | -3.29±7.27 | 76.25±11.21 | 75.00±12.28 | –1.25±5.68 |
| Central SBP (mm Hg) | 97.54±6.84 | 99.79±9.57 | 2.25±6.97 | 96.04±8.00 | 97.08±8.45 | 1.04±5.88 |
| Central DBP (mm Hg) | 64.31±5.82 | 65.46±7.02 | 1.13±5.52 | 62.63±6.26 | 64.00±5.07 | 1.38±4.58 |
| AI (%) | 45.13±12.41 | 48.29±11.45 | 3.17±8.42 | 46.25±13.12 | 45.92±13.07 | –0.33±11.72 |
| baPWV (cm/s) | 1067.08±247.03 | 1448.25±335.28*** | 381.16±244.87 | 928.46±203.89 | 1276.80±806.86** | 348.33±242.82 |

*P<0.05, **P<0.001, ***P<0.0001

MAST which point towards elevated sympathetic activity that eventually leads to increased peripheral vascular tone. These kinds of responses are predictors of future increase in blood pressure and for hypertension status (10). However, HR response was significantly less during MAST in late follicular phase. Moreover, a decrease in HR has been observed in 62.5% subjects during late follicular phase and 41.6% subjects in luteal phase. Females can be categorized into “reactive female” and “non-reactive female” on the basis of peripheral vascular reactivity to mental stress as mentioned previously. Furthermore, this decline in peripheral vascular response may enhance the risk of major cardiovascular events in future (12).

The basal value of baPWV is higher in follicular phase than luteal phase, which corroborates the finding of previous study (13). baPWV is significantly higher (P=0.0001 and P=0.001) during MAST in both phases. This denotes decrease vascular compliance in response to stressful stimulus. However, no significant change in MAST score is observed in both phases. It infers that the subjects perform optimally irrespective of phase of menstrual cycle, albeit the vascular system of the individual bears the brunt in stressful situation which may prove detrimental in the long run.

This study therefore concludes that the effect of laboratory stressor in the form of Mental Arithmetic Stress Test (MAST) superimposed on the effect of ovarian hormones, decreases arterial compliance as measured indirectly by baPWV.

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**Conflict of interest**

None

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