ORIGINAL RESEARCH PAPER
Volume - 13 | Issue - 11 | November - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

EFFECT OF PREGNANCY ON CARDIOVASCULAR AUTONOMIC FUNCTION

Physiology

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ABSTRACT

Background: Pregnancy is a dynamic process where the body adapts to the physiological changes in many organ systems, significantly the cardiovascular system to accommodate the demands of the growing fetus. Autonomic nervous system, both sympathetic and parasympathetic has a pivotal role in the cardiovascular regulation. These changes during pregnancy reflected in the cardiovascular autonomic function, if detected early may have an advantage in the early identification of pregnancy associated cardiovascular complications. **Aim & Objectives:** The aim of the study was to compare the cardiovascular autonomic function between the pregnant and non-pregnant women. **Materials And Methods:** The study was conducted in the Department of Physiology, JNIMS during the period of September 2020 to November 2022. A total of 25 normal pregnant women and 25 normal non pregnant women within the age group of 20 to 40 years were included in the study. Cardiovascular autonomic function test was done using Ewing's battery of tests. Statistical analysis was done by using unpaired t test. **Results:** We observed from our study that Cold Pressor test (CPT) and the Heart Rate in the pregnant women (8.88±1.87 mmHg and 24.96±3.61 beat/min) respectively and was found to be significantly lower as compared to non-pregnant women (12±2.94 mmHg and 31.56 ±4.15 beat/min) respectively. **Conclusion:** We concluded from our study that the cardiovascular autonomic function was altered during pregnancy to maintain the cardiovascular integrity.

KEYWORDS

Pregnancy, Cardiovascular Autonomic Function Test, Cold pressor test, δ heart rate

INTRODUCTION

Pregnancy is a dynamic process which is associated with physiological changes significantly in the cardiovascular system. These changes are mechanisms that the body has adapted anatomically, physiologically, and biochemically, that starts soon after fertilization and continue throughout gestation to meet the increased metabolic demands of the mother and fetus and to ensure adequate uteroplacental circulation for fetal growth and development. Most of these changes are due to the activity of various sex steroids and other hormones secreted mainly by the placenta.[1,2]

During pregnancy, blood flow to various organs increases to meet the increased metabolic needs of tissues. Thereby, there is an increase in cardiac output, arterial compliance, and extracellular fluid volume and decreases in blood pressure (BP) and total peripheral resistance.[3,4]

The increase in cardiac output is well established by 5 weeks of gestation and increases to 50% above pre pregnancy levels by 16 to 20 weeks of gestation. The rise in cardiac output typically plateaus after 20 weeks of gestation and remains elevated until term. The increase in cardiac output are associated with significant increases in stroke volume and heart rate (HR). Cardiac output increases throughout pregnancy.[5,6]

The rapid expansion of blood volume begins at 6 to 8 weeks' gestation and plateaus at approximately 32 to 34 weeks' gestation. Plasma volume increases progressively throughout normal pregnancy.[10,11] The expanded extracellular fluid volume accounts for 6 to 8 kg of weight gain. Healthy gestational weight gain (GWG) varies according to pre-pregnancy weight category (25-35 lb for normal weight, 15-25 lb for overweight, and 11-20 lb for obese).[7,8]

Substantial evidence suggested that nitric oxide (NO) production is elevated in normal pregnancy and that increase in nitric oxide appears to play an important role in the vasodilation of pregnancy.[9]

Autonomic nerves have pivotal role in the regulation of the cardiovascular system both in ensuring optimal function during various activities in health, and also in mediating several of the manifestations of cardiac diseases.[10]A well controlled interaction between the sympathetic and parasympathetic system is necessary for adapting the cardiovascular hemodynamic changes during normal pregnancy, failure of which may result in pregnancy complication.[11,12]

A battery of standardized quantitative autonomic function tests using cardiovascular reflexes, which are otherwise simple, noninvasive and reproducible, have been used to assess cardiovascular autonomic function. The important parasympathetic cardiovascular autonomic reflex tests include Valsalva maneuver, heart rate variability during orthostatic test and deep breathing test. The important sympathetic cardiovascular autonomic reflex tests are blood pressure changes during isometric hand grip exercise and orthostatic test.[13]

MATERIALAND METHODS

This cross-sectional study was conducted at Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Imphal, Manipur during the period from September 2020 to November 2021. A total of 25 normal pregnant women and 25 normal non pregnant women within the age group of 20 to 40 years were recruited from Obstetrics and Gynaecology Out-Patient Department, JNIMS, Imphal East, Manipur. The Institute Ethical Committee clearance was taken from the Institutional Ethics Committee (IEC) of the Institute. An informed written consent was taken from all the subjects before the recruitment

of the study. All the subjects without history of multiple pregnancy, hypertension, preeclampsia, eclampsia, DM, GDM, CVD, lung disease & Hb level < 10gm% were included in the study. Autonomic function test (AFT) was done by utilizing "Ewing's battery of tests" in the AFT lab Dept. of Physiology Subjects were classified into healthy pregnant women and age-matched healthy non-pregnant women

Tests were done by using hand dynamometer (INCO), Student's physiography single channel (INCO) Mercury sphygmomanometer (Bio plus) and Stethoscope Cardiovascular sympathetic status assessment was done by:

I) Sustained Hand grip test (SHGT):

After recording the basal blood pressure, the patient was asked to grip a hand dynamometer three times with his/her dominant hand using maximal effort, at an interval of two minutes each. All the three readings on the dynamometer (force generated by subject in kg) were noted and 30% of mean maximal voluntary capacity was calculated. The patient was then asked to grip the dynamometer at 30% of his/her maximum capacity and to maintain it for 2-3 minutes. Blood pressure (BP) was recorded in the contra-lateral arm every minute during contraction. Maximum change in both systolic and diastolic BP was compared with basal BP

ii) Cold pressor test:

The cold water of 10℃ was prepared and the subject was asked to immerse his/her hand in water upto the wrist for 1 minute. The hand was covered by a towel after the hand was removed from the water. The changes in blood pressure during the last 10 seconds of the test are compared to baseline values. The blood pressure was taken at just before the hand takes out of water (i.e, at the end 1 minute of immersion). The blood pressure was measured again at 1.5 min and 4 min after the hand was withdrawn from the cold water

iii) Blood pressure response to standing

After making patient to lie down supine for 5 minutes, basal BP recording was done. The patient was then asked to stand up and BP was recorded at 0 and 1 minute intervals. Change in BP was given by difference between the basal BP and BP during standing.

Cardiovascular parasympathetic status assessment was done by:

i) Deep breathing test

The patient was instructed to maintain deep breathing at a rate of six breaths per minute and was made to lie down comfortably in supine position with head elevated to 30 degrees. Electrogram (ECG) electrodes was connected for recording ECG (lead II) using the single channel Student's Physiograph, INCO. While patient was breathing deeply at the rate of 6 breaths per minute (allowing 5 seconds each for inspiration and expiration), maximum and minimum heart rates was recorded with each respiratory cycle. Expiration to inspiration ratio (E:I ratio) was determined as sum of 6 longest R-R intervals, each of 6 repetitions divided by the sum of 6 shortest R-R intervals. The maximum and minimum R-R interval was identified and converted into HR, giving the HRV in one minute (δ HR).

ii) Heart rate response to standing

The patient was made to lie down in supine position. The patient was asked to relax completely for a minimum period of 10 minutes. The patient was asked to stand up immediately and remain motionless while ECG was recorded for 1-3 minutes. Heart rate response to standing was determined by using the 30:15 R-R ratio which was longest RR interval occurring about 30 beats after standing divided by shortest RR interval which occurred about 15 beats after standing.

Statiscal Analysis

a. The data were entered in MS excel and Statistical Package for Social Sciences (SPSS) version 23. The statistical analysis was done by applying descriptive statistics i.e., mean ± SD followed by Student's unpaired t test for comparison and p value ≤ 0.05 was considered as significant.

RESULTS

The study was conducted in the Department of Physiology, JNIMS during the period of September 2020 to November 2022. A total of 25 normal pregnant women and 25 normal non pregnant women within the age group of 20 to 40 years were included in the study. Cardiovascular autonomic function test was done using Ewing's battery of tests. Statistical analysis was done by using unpaired t test.

Table 1: Interpretation of Autonomic Function Tests

Tests	Method	Normal	Borderline	Abnormal
Cold Pressor Test	Highest Diastolic blood pressure- Baseline diastolic blood pressure	≥10 mmhg	-	<10 mmhg
Heart rate variation during deep breathing (by ECG)	Maximum-minimum of heart rate	≥15 beats/minute	11-14 beats/minute	≤10 beats/min
Immediate heart rate response to standing (by ECG)	R-R interval ratio of 30th beat:15th beat	≥1.04	1.01-1.03	≤1.00
Blood pressure response to standing	Measure blood pressure in supine and then in stand	≤10 mmHg	11-29 mmHg	≥30 mmHg
Blood pressure response to sustained handgrip (2min)	Measure diastolic blood pressure after 2 min using of hand grip	≥16 mmHg	11-15mmHg	≤10 mmHg

Table 2: Demographic profile of pregnant women (n = 25)

Characteristics	Pregnant women (Mean±SD)
Age (years)	**28.20 ± 4.87**
Weight (Kg)	**56.28 ± 7.29**
Height (cm)	**151.76 ± 5.89**
Period of gestation (weeks)	**21.32 ± 8.36**
BMI	**24.44 ± 2.95**

Table 3: Demographic profile of Non Pregnant women (n=25)

Characteristics	Non-Pregnant women (Mean ± SD)
Age (years)	28.20 ± 4.87
Weight (Kg)	60.64 ± 6.85
Height (cm)	156.56 ± 4.24
BMI	24.76 ± 2.82

Table 4: Status of autonomic function test

Parameter	Non pregnant	Pregnant	P-value
Parasympathetic			
E:I	1.23±0.16	1.19±0.1	0.417
30:15	1.218±0.127	1.184±0.085	0.269
δ HR	31.56±4.154	24.96±3.616	0.001**
Sympathetic			
BP response to standing	4.84±1.864	3.92±2.06	0.104
SHGT	10.28±3.21	9.92±3.62	0.711
CPT	12±2.94	8.88±1.88	0.001**

**p≤0.001

Table 2 & Table 3 shows demographic profile of 25 pregnant women & 25 non-pregnant women respectively. 25 pregnant women with mean age of 28.20 ± 4.87, BMI of 24.44 ± 2.95 & 25 non pregnant with mean age of 28.20 ± 4.87, BMI of 24.76 ± 2.82 are found.

Table 4 shows comparison between pregnant & non pregnant women for both sympathetic & parasympathetic tests. The study showed a significant change in δ HR (p≤ 0.001) & CPT (p≤ 0.001)

DISCUSSION

We observed from our study that Cold Pressor test (CPT) and the Heart Rate in the pregnant women was found to be significantly lower as compared to non-pregnant women, which suggests that both the sympathetic and parasympathetic response are reduced. Similar findings of showing decrease sympathetic and parasympathetic nervous activity in the 2nd trimester of pregnancy was seen in some studies. [14,15,16]

Ghuge et al. conducted a study on total 100 healthy pregnant women to investigate the sequential changes in cardiovascular activity during the three trimesters of pregnancy. They observed that sympathetic activity was decreased more in 2nd trimester, less in 1st trimester and least in last trimester i.e, towards prepregnant level which is similar with our study.[16]

Athani et al. conducted a comparative study cardiovascular autonomic function tests between 67 second trimester pregnant women and 67 healthy non-pregnant women. They found decreased sympathetic and parasympathetic nervous activity in the second trimester of pregnancy when compared to controls which is similar to our findings.[14]

Ekholm et al. studied on the physiological responses to noninvasive cardiovascular autonomic function tests in 60 healthy women with singleton pregnancy and the cardiovascular responses were blunted in mid-pregnancy showing a decrease in parasympathetic cardiovascular control.[15]

CONCLUSION

Autonomic nervous system, both sympathetic and parasympathetic has a pivotal role in the cardiovascular regulation during pregnancy. These changes, if detected early may have an advantage in the early identification of pregnancy associated cardiovascular complications like PIH. It opens doors for the use of non-invasive autonomic function test as provocative test in screening women at higher risk of PIH

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