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A Study of Maternal Cardiovascular ReflexesDuring Pregnancy

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Abstract

Background: *Pregnancy is associated with tremendous changes in the maternal cardiovascular autonomic system. Some studies have reported conflicting cardiovascular autonomic activity during pregnancy.So the present study was conducted to understand the sequential changes in the maternal cardiovascular autonomic system during pregnancy.*

Materials and methods:*A total of 25 healthy normotensive women with singleton pregnancy in the age group of 20-30 years were included in the study.Blood pressure response to isometric handgrip using a spring dynamometer was done for evaluation of sympathetic activity. Evaluation of parasympathetic activity was done by recording heart rate response to deep breath. The data collected were entered using SPSS version 21 (IBM). Analysis was done using one-way ANOVA.*

Results: *In our study sympathetic activity was observed to be decreased the most in 2nd trimester (6.40±2.76), as compare to first (10±4.20) and third trimester (13.04±2.95). The parasympathetic activity was observed to decrease starting from the second trimester (1.17±0.04) and decreasing the most in the third trimester (1.15±0.02).*

Conclusion:*Maternal cardiovascular sympathetic response decline from the first trimester and reaches its nadir in the second trimester, and the parasympathetic drive starts decreasing from the second trimester and reaches its peak in the third trimester.*

Keywords: *Pregnancy, blood pressure, heart rate, sympathetic, parasympathetic*

I. Introduction

Pregnancy is associated with tremendous changes in the maternal cardiovascular autonomic system. Increased in heart rate (HR) and stroke volume (SV) resulting in an increased cardiac output (CO) has been observed during pregnancy[1-2]. Blood pressure (BP) falls progressively in the first half of pregnancy and then increases gradually as pregnancy advances[3]. A progressively increasing fall in the uteroplacental vascular resistance effecting a variation in the systemic vascular resistance has been documented to be the major caused of this fall in BP[4]. Autonomic nervous system (ANS) plays an important role for this physiological changes and circulatory adaptation associated with pregnancy[5]. Earlier study have documented an increased sympathetic and a decreased parasympathetic activity in the second half of pregnancy[6]. It has been proposed that a decrease in baroreceptormediated inhibitory restraint on central sympathetic outflow might be the explanation of this increased sympathetic drive[7,8]. Hormonal factors or expansion of blood volume associated with normal pregnancy may also affect sympathetic baroreflex function[9]. However, somestudies have reported conflicting results of increased[10,11]and unchanged[12]cardiovagalbaroreflex sensitivity during pregnancy.So the present study was conducted to understand the sequential changes in the maternal cardiovascular autonomic system during pregnancy.

II. Materials And Methods

This was a prospective study, conducted in the department of Physiology in collaboration with Department of Obstetrics and Gynecology, Regional Institute of Medical Sciences (RIMS), Imphal, Manipur, India. Ethical approval was taken from Research Ethics Board, RIMS, Imphal. A total of 25 healthy normotensive women with singleton pregnancy in the age group of 20-30 years were included in the study. The subjects were recruited from the Antenatal clinic of the same Institute in their first trimester and were followed up regularly till their third trimester. Pregnancy complicated with hypertension, diabetes mellitus, or any other systemic diseases that might affect maternal cardiovascular autonomic system were excluded from the study. After proper explanations of the study protocols, written informed consent was taken from all the subjects.

Blood pressure response to isometric handgrip using a spring dynamometer was done for evaluation of sympathetic activity. The isometric handgrip test was done with the dominant hand at one-third of the predetermined maximal isometric tension (T_{max})[13]. Handgrip was maintained up to a maximum of 4 min. Blood

pressure was measured at rest and at 2 min intervals during handgrip by the standard auscultatoryRiva Rocci method from the left upper arm. Diastolic blood pressure was measured at the disappearance of Korotkoffs sounds (phase V). The alterations in blood pressure just before the release of spring dynamometer was taken as index of response to hand grip test.

Evaluation of parasympathetic activity was done by recording heart rate response to deep breath. The subject was instructed to breathe deeply at a rate of six breaths per minute to produce a maximum variation in the heart rate (HR). HR was recorded on a standard ECG from lead II. The E:I ratio which is the ratio between the mean of maximum R-R intervals during deep expiration to the mean of minimum R-R intervals during deep inspiration was calculated[13-14] . The tests were done between 10 A.M. – 12 Noon.

1.1 Data Analysis

The data collected were entered using SPSS version 21 (IBM). Analysis was done using one-way ANOVA. All values were expressed as mean ± standard deviation. $P<0.05$ was taken as significant.

III. Results

Fig 1 shows the mean and standard deviation of the demographic profile of the patients.Sympathetic response was observed to be decreased the most in 2nd trimester (6.40±2.76) as shown in Fig 2. From Fig 3, it is evident that parasympathetic response decreases with advancing pregnancy, decreasing the most in the third trimester(1.15±0.02).Table 1 shows the comparison of mean and standard deviation of both sympathetic and parasympathetic responses among the three trimesters. Both sympathetic and parasympathetic responses showsignificant changes with p value of less than 0.05among the three trimesters.

Fig 1: Demographic profile of the Patients

No of Patients (n)	Age (Years) Mean±SD	Height (Cm) Mean±SD	Weight (Kg) Mean±SD	BMI Mean±SD
25	25.88±3.29	155.76±2.89	54.16±3.2	22.35±1.43

Fig 2:Sympathetic test in the three trimesters

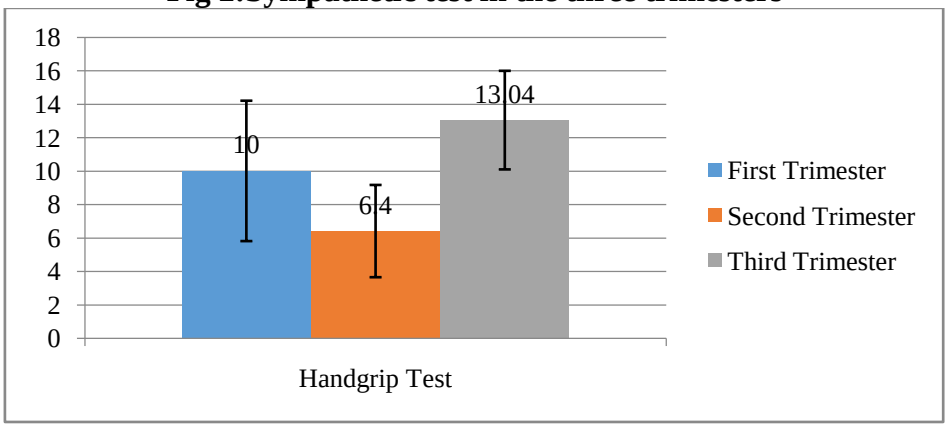

Fig 3:Parasympathetic test in three trimesters

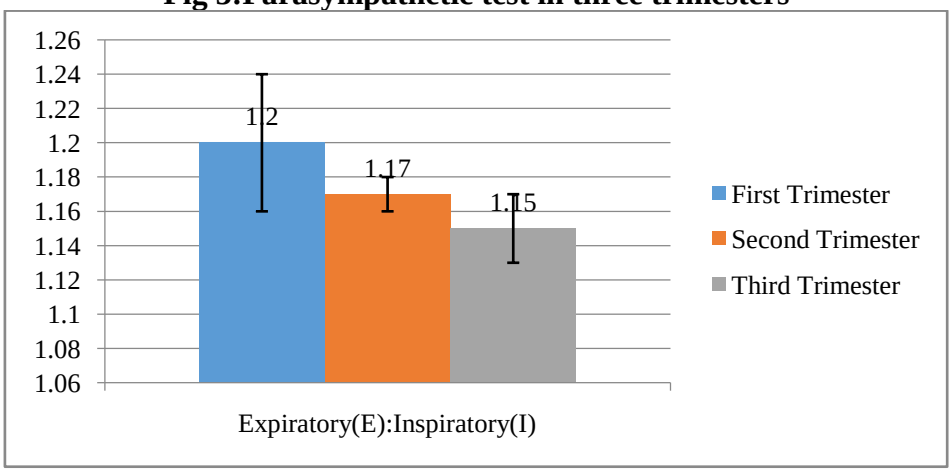

Table 1: Trimester wise comparison of mean values of ANS test				
ANS Test	**Trimester (I) Mean±SD**	**Trimester (J) Mean±SD**	**Mean Difference (I-J)**	**P value**
Sympathetic Test (HGT)	**First** 10.00±4.20	**Second** 6.40±2.76	3.600	0.001
	First 10.00±4.20	**Third** 13.04±2.95	3.040	0.006
	Second 6.40±2.76	**Third** 13.04±2.95	0.026	0.000
Parasympathetic Test E:I	**First** 1.20±0.04	**Second** 1.17±0.01	0.026	0.016
	First 1.20±0.04	**Third** 1.15±0.02	0.051	0.000
	Second 1.17±0.01	**Third** 1.15±0.02	0.025	0.019

IV. Discussion

In this study, we examined the impact of different stages of pregnancy on the changes of maternal cardiovascular autonomic system. The result indicates that the system changes in a certain pattern during pregnancy. The handgrip isometric exercise reliably increases plasma norepinephrine[15-17]. In the early pregnancy an overall decrease in uteroplacentalvascular tone and a rise in arterial compliance occurs[18]. In our study sympathetic activity was observed to be decreased the most in 2nd trimester (6.40±2.76), as compare to first (10±4.20) and third trimester (13.04±2.95). Rosenfeld CR found no change in the maternal arterial blood pressure or number of maternal blood vessel in early pregnancy. This facilitates a maintained placental perfusion pressure in the face of episodic stress effect[19]. Another landmark finding of peculiarity in the sympathetic response in midpregnancy is the study finding of Nadanetal[20]. In normal midpregnancy, an associated attenuated pressure response to endogenous vasoconstrictor such as angiotensinII, catecholamines, arginine vasopressin occur. At the same time the maternal placental vascular bed becomes large and matured with the blood flow low on weight basis reflecting ever increasing size and weight of placenta and fetus i.e. metabolically active tissue. This obviously can lead to a fall in maternal blood pressure response in order to sustain the placental perfusion pressure during midpregnancy. A study by Morris et al[21]also showed that total peripheral resistance continued to decrease up to 25th week. Study by Assalialso concluded that increased sympathetic response prevails during the second half of pregnancy supporting the present study. This view was based on the assumption that the action of ganglionic blocking agents on blood pressure is exceptionally potent in pregnancy[22].

The parasympathetic activity was observed to decreasestarting from the second trimester (1.17±0.04) and decreasing the most in the third trimester (1.15±0.02). Ashwiniet al[23]while studying parasympathetic activity among pregnant and non-pregnant female in their first trimester also concluded that there was not much significant difference. The changes in the parasympathetic nervous system may be due to decrease vagal baroreflex sensitivity[18]. Study performed by Ekholmet al[24] also reflected a decrease in heart rate variability and baroreflex sensitivity during pregnancy.For mechanical reasons the growing uterus may have diminished pulsatility of the venous blood flow into the thorax. This could reduce the oscillation of right atrial distension and thus lead to decreased heart rate variability.

V. Conclusion

Both sympathetic and parasympathetic cardiovascular responses undergo certain physiological changes during pregnancy. Our study support that cardiovascular sympathetic response decline from the first trimester and reaches its nadir in the second trimester, and the parasympathetic drive starts decreasing from the second trimester and reaches its peak in the third trimester.From the study it can be implicated that such sequential maternal cardiovascular autonomic changes are important for maternal adaptation to pregnancy and proper maintenance of perfusion pressure in nurturing the growing fetus, failure of which may be associated with complication like pregnancy induced hypertension, intrauterine growth retardation (IUGR) etc.However, further studies correlating cardiovascular autonomic functions between these normal and complications like pregnancy induced hypertension, IUGR, gestational diabetesshould be conducted in order to understand the derangement and early detection of the later.

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