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Original Research Article

Comparative Study of Cardiovascular Autonomic Function Tests amongst Pregnant Women of First Trimester and Non Pregnant Women

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ABSTRACT

Background: All types of behavioral and hormonal changes occur in women especially during reproductive life. Most of the behavioral and emotional patterns are exhibited through autonomic nervous system. Therefore, it is worth, while to assess autonomic functions during various phases of woman's reproductive life. Testing of autonomic functions will also help to interpret the test results such as whether these changes are within physiological limit or pathological. These would also help to predict any existing autonomic dysfunction during various phases of woman's life.

Objectives: This study was conducted to assess the significance of autonomic function tests amongst pregnant women of first trimester and non pregnant women.

Materials and Methods: A comparative study was carried out in the Department of Physiology of Rural Medical College, Loni, Maharashtra during the period of June 2004 to May 2005. A consecutive 50 women, who were pregnant and equal numbers of non-pregnant women during study period, were included in the study. Hence the total 100 women (50 each from pregnant and non-pregnant group) were interviewed and examined. Data were analysed statistically using percentage, proportions and Z test.

Results: In the present study, for sympathetic activity, it was observed that orthostatic variation in arterial blood pressure and cold pressor test were statistically significant ($p<0.01$) as compared to non-pregnant state. For parasympathetic activity, it was observed that heart rate response, E:I ratio and valsalva ratio were not significant ($p>0.05$) in both pregnant and non-pregnant state.

Conclusion: In the present study, there were changes to blood pressure in the first trimester of pregnancy, reflecting sympathetic activity as compared to non pregnant group while the tests for parasympathetic activity did not show any difference in both the groups.

Key words: Autonomic function tests, pregnant women, Cold pressor test

INTRODUCTION

Pregnancy is associated with substantial changes in the cardiovascular system. [1] The action of the autonomic nervous system is essential for the circulatory adaptations in pregnancy and nourishing growing fetus. The autonomic nervous system is anatomically and functionally divided into two distinct interacting divisions i.e. the sympathetic and parasympathetic. Cardiac output, stroke volume and heart rate are increased in pregnancy. In the first half of pregnancy, systemic vascular resistance and blood pressure decrease. During last trimester, systemic vascular resistance increases. [2] Pregnancy is associated with higher baroreceptor sensitivity. As pregnancy advances there is higher sympathetic and lower vagal modulation. [3] A well controlled interaction between the sympathetic and the parasympathetic system is necessary for adapting the cardiovascular system to various haemodynamic needs not only under pathophysiological circumstances, such as haemorrhage and shock, but also in physiological states such as pregnancy. [4] Pregnancy is associated with profound adaptive changes in the maternal hemodynamics. Autonomic nervous system plays a major role in the regulation of cardiovascular function but its role in pregnancy is less ill defined. [5] Determination of the cyclical changes of heart rate over time does not only allow an assessment of sympathovagal control of the sinuatrial node under resting conditions but also enables researchers to non-invasively explore baroreflex mechanisms especially when spectral analysis of blood pressure variability is obtained simultaneously. Compared with the classical pharmacological method of arterial baroreflex testing, this newer technique, due to its non-invasive nature, represents a real advantage for studying pregnant women as it is safe and can be performed easily and repeatedly. [6] Hence this study was conducted with an objectives that to study the physiological responses to non invasive cardiovascular autonomic function tests in first trimester pregnant women and also to compare autonomic functions in first trimester pregnant women with non pregnant women.

MATERIALS AND METHODS

A comparative study was carried out amongst pregnant and non pregnant women at Department of Physiology of Rural Medical College, Loni, Maharashtra, India during the period of June 2004 to May 2005. A total of 100 women (which include 50 pregnant women attending antenatal (ANC) clinic during first trimester of pregnancy and equal numbers of non-pregnant healthy women as a controls), aged between 18-25 years during study period were included in the study after approval of the protocol by institute's ethics committee. The exclusion criteria for the study were the participants with complicated pregnancy like twin gestation, preeclampsia, gestational diabetes, placenta previa, bad obstetric history, chronic hypertension, chronic renal disease, diabetes mellitus, cardiopulmonary diseases, and chronic respiratory illness and on medications like antihypertensive were not included in the study. All subjects were explained of the procedure to be undertaken and a written consent was obtained. All 50 pregnant women attending antenatal (ANC) clinic were assessed for autonomic function tests during first trimester of pregnancy. Physical parameters noted in each participant were age in years and weight in Kgs. Blood pressure was recorded with sphygmomanometer by auscultatory method. Electrocardiogram (ECG-CARDIART 108T-British physical laboratories India limited) recordings were carried out in Lead II. All tests were carried

out with the consent of participants. The participants were made to rest for 10 minutes before recording their base line systolic and diastolic blood pressure in supine posture, as per standard procedures. A gap of 30 minutes was observed in between performing two tests.

After giving rest for 10 minutes, the following parameters were recorded.

Tests performed to assess sympathetic functions:

1. **Pulse rate (per minute)** by palpatory method.
2. **Arterial blood pressure (mm of Hg)** recording by auscultatory method.
3. **Orthostatic variation in arterial blood pressure:**

Procedure: After recording the blood pressure in supine position by auscultatory method, the subject was asked to stand up and after 50 seconds the blood pressure was recorded. Any change in blood pressure is determined as the difference between the recording while supine and standing position.

***Result*:** A decrease in systolic blood pressure >20mm of Hg and decrease in diastolic blood pressure >10mm of Hg during 1 minute standing suggest autonomic dysfunction.

4. Cold Pressor Test (CPT):

***Procedure*:** The subject was asked to immerse the hand in ice cold (4^0C) water for one minute and the blood pressure was recorded in supine position by auscultatory method. This maximum blood pressure recording obtained with a hand in 4^0C water was taken as an index of response.

***Result*:** Normally both systolic and diastolic blood pressure should increase at least by 10 mm of Hg at the end of 1 minute of immersion. This is used to evaluate the peripheral sympathetic vasoconstrictor mechanism.

Tests performed to assess parasympathetic functions:

1. Heart rate response:

Procedure: The subject was asked to lie down comfortably and the heart rate was recorded. Then the subject was asked to stand up and immediately the heart rate was recorded. The heart rate was calculated with the help of R-R interval. Response was taken as a difference between the heart rate in supine and standing positions.

Result: Normally heart rate should increase at least by 10 beats per minute in standing position. The absence of increase in heart rate during standing position has been interpreted as an impairment of autonomic function of heart.

2. Expiratory: Inspiratory ratio (E: I ratio):

***Procedure*:** The subject was asked to lie down comfortably and was asked to take deep breaths slowly in and out, approximately at 6 breaths per minute i.e. 5 seconds inspiration and 5 seconds expiration. The maximum and minimum R-R intervals during each phase of respiration were recorded. The heart rate was calculated and the variation during respiration was observed.

***Result*:** E:I ratio is taken as the ratio of longest R-R interval during expiration to the shortest R-R interval during inspiration. E:I <1.2 is abnormal.

3. Valsalva ratio:

***Procedure*:** The subject was asked to take deep breaths with closed nostrils and puff the cheeks simultaneously for 15 seconds and then was asked to release the strain by doing forceful expiration. The heart rate was recorded and calculated during the strain and after release of strain.

***Result*:** Normally heart rate is increased during the strain and this raised heart rate is due to baroreflex stimulation to the fall in the blood pressure seen as a result of increased intrathoracic pressure (decreased venous return). On release of strain the cardiac output is restored and there is an

increase in blood pressure. Valsalva ratio is taken as the ratio of longest R-R interval after release of strain to the shortest R-R interval during strain. It is used as an index of cardiac vagal function. A ratio of < 1.2 is abnormal.

Statistical analysis: Data were entered in Microsoft Excel and results were analysed statistically using percentage, proportions and Z test. When z-value was more than 1.96, the p-value will be less than 0.05 and observed difference was consider to be statistically significant.

RESULTS

Resting and standing systolic blood pressure values in the study group were found to be 115.84 ± 5.18 mm Hg and 112.8 ±8.17 mm Hg while diastolic blood pressure values were 70.2 ± 7.3 mmHg and 78.32 ± 6.32 mm Hg respectively in pregnant women group. Table 1 depicts the mean ±SD increase in systolic and diastolic blood pressure during cold pressor test (CPT) and Orthostatic variation in arterial blood pressure in all these subjects respectively. The increase in blood pressure (systolic and diastolic) during CPT and Orthostatic variation in arterial blood pressure, was found to be more in pregnant women as compared to non pregnant women and was statistically significant ($p<0.01$).

Table 1: Comparison of autonomic function tests among study population for sympathetic activity.

Parameters reflecting sympathetic activity	Pregnant Women (First trimester) (n=50)	Non-pregnant Women (n=50)	Z-value	p-value
	Mean ±SD	Mean ±SD		
Pulse rate *(per minute)*	80.68 ± 7.99	78.32± 4.05	1.85	p>0.05
Supine SBP (mm Hg) DBP (mm Hg)	 115.84 ± 5.18 70.2 ± 7.3	 112.96 ± 4.19 71.96 ± 4.63	 1.47 0.01	 p>0.05 p>0.05
Standing SBP (mm Hg) DBP (mm Hg)	 112.8 ±8.17 78.32 ± 6.32	 109.72 ± 7.48 77.92 ± 4.55	 1.17 0.36	 p>0.05 p>0.05
Orthostatic variation in arterial blood pressure SBP (mm Hg) DBP (mm Hg)	 -3.04 ± 0.93 7.96 ± 2.35	 -2.16 ± 1.07 5.44 ± 1.83	 1.99 6.0	 p<0.05 p<0.01
Cold Pressor Test SBP (mm Hg) DBP (mm Hg)	 122.92 ± 4.63 86.84 ± 4.9	 118.96 ± 3.78 83.56 ± 6.06	 4.71 2.98	 p<0.01 p<0.01

Table 2: Comparison of autonomic function tests among study population for parasympathetic activity

Parameters reflecting parasympathetic activity	Pregnant Women (First trimester) (n=50)	Non-pregnant Women (n=50)	Z-value	p-value
	Mean ±SD	Mean ±SD		
Heart Rate Response	35.76 ± 15.97	32.64 ± 14.3	1.16	p>0.05
Expiratory:Inspiratory Ratio	1.38 ± 0.29	1.49 ± 0.91	1.78	p>0.05
Valsalva Ratio	1.21 ± 0.87	1.28 ± 0.69	1.62	p>0.05

It was seen from Table 2 that the heart rate response, expiratory: inspiratory ratio and valsalva ratio were not significant statistically ($p>0.05$) in both pregnant and non-pregnant state for the autonomic function tests for parasympathetic activity were compared during first trimester of pregnancy and non-pregnant women.

DISCUSSION

There was a definite association between gestation and the valsalva ratio when it was adjusted for baseline heart rate. The mean values were above the lower limits of normal pregnant women but below the non pregnant mean values of control subjects with downward trend through to the 29^{th} to 32^{nd} week of pregnancy. In non pregnant women, both systolic and diastolic blood pressure increased immediately on standing and returned to basal level by 10 minutes, while in pregnant women, systolic and diastolic blood pressure decreased promptly on standing. Pulse rate remained unchanged in both. [7]

Similarly in the present study, responses to orthostatic variation in arterial blood pressure mainly diastolic blood pressure and cold pressor test were significantly ($p<0.05$) altered in the first trimester of pregnancy as compared to that of non-pregnant state, reflecting higher sympathetic activity. The responses of parasympathetic activity did not differ in these two groups. The association between alteration in autonomic cardiovascular control and development of hypertension in pregnancy has been investigated for some time. Use of non invasive methods for assessment of autonomic functions has been an area of special interest since they have the advantage of having minimal risk for the mother and the fetus. [8] The beginning of pregnancy is associated with sympathetic reactivity, whereas the later half of pregnancy is characterized by increased haemodynamic stability during orthostatic stress. The heart rate response to the valsalva manoeuvre is blunted in mid-pregnancy, possibly due to changes in the baroreflex activity and increased maternal blood volume. [9] This was assessed by recording a single variable like heart rate variability but in the present study multiple variables were assessed reflecting that there was an increased sympathetic activity as compared to parasympathetic activity during first trimester of pregnancy. Another study by Page MM revealed that heart rate responses in both the groups were similar but blood pressure changes were slightly weaker in pregnant women. [10]

CONCLUSION

In our study, there were significant changes to orthostatic variation in arterial blood pressure and cold pressor test in the first trimester of pregnancy, reflecting higher sympathetic activity as compared to non pregnant group while the tests for parasympathetic activity did not show any difference in both the groups. However, further study is required to correlate autonomic nervous system functions with hormonal imbalance showing significant fluctuation in reproductive steroids.

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