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Original Research Article

Comparative Assessment of Autonomic Function Testing During Different Trimesters of Pregnancy: An Observational Study

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Abstract

Aim: A comparative analysis of autonomic function testing throughout several trimesters of pregnancy.

Material and Methods: This cross-sectional research comprised 120 pregnant women from the outpatient Physiology Department of SKMCH, Muzaffarpur, Bihar, India. All 40 first-, second-, and third-trimester women were informed about the surgery and gave written permission. Autonomic function tests were performed on all 120 pregnant women at the ANC clinic throughout each trimester. The window-based cardiac autonomic neuropathy analyzer CAN WIN performed cardiovascular sympathetic and parasympathetic tests with interpretation.

Results: It found no statistically significant differences in age and height between I-Trimester (40) Women's, II-Trimester, and III-Trimester Women's. ($p>0.05$). However, the mean weight difference between IIIrd trimester and non-pregnant and IIIrd trimester and IInd trimester was statistically significant. Women in all three groups had mild sympathetic dysfunction. Females in group I exhibited normal parasympathetic function, mild to moderate parasympathetic dysfunction, and moderate sympathetic dysfunction. Women in group II had mild parasympathetic and moderate sympathetic dysfunction. Women in group III had moderate parasympathetic and sympathetic dysfunction.

Conclusion: Changing sympathetic and para-sympathetic activities in various trimesters show that the body adapts to the developing foetus, resulting in appropriate pregnancy outcomes.

Keywords: Pregnancy, sympathetic activity, parasympathetic activity, cardiovascular Stability

Introduction

Pregnancy triggers extensive physiological changes that have a substantial impact on the autonomic nervous system (ANS). The autonomic nervous system (ANS), responsible for regulating involuntary physiological processes including heart rate, blood pressure, and digestion, undergoes changes to assist the developing foetus and ensure the well-being of the mother. The autonomic modifications during pregnancy alter in each trimester, as they adapt to the evolving needs of the mother's body. [1] During the first three months of pregnancy, there are notable shifts in hormones, namely a rise in progesterone and oestrogen, which lead to considerable alterations in the cardiovascular system. Hormonal surges may affect the autonomic control, resulting in fluctuations in heart rate and blood pressure. The body initiates physiological adjustments in response to these hormonal fluctuations, in anticipation of the heightened metabolic requirements associated with pregnancy. [2]

During the second trimester, the cardiovascular system undergoes further adaptations, resulting in more noticeable increases in both cardiac output and blood volume. During this stage, there is often a change in the equilibrium between sympathetic and parasympathetic processes as the maternal body becomes stable after the early hormonal shifts. Increased blood volume and cardiac output are essential for sustaining the developing foetus and maintaining the mother's cardiovascular system. [3]

During the third trimester, the mother has the highest level of physiological demands. The increased size of the uterus and the higher blood volume put extra strain on the cardiovascular system, requiring further adjustments by the autonomic nervous system. Comprehending these alterations is crucial for recognising possible consequences such as prenatal hypertension and preeclampsia, which are illnesses linked to autonomic dysfunction. [4,5] Autonomic function tests, such as heart rate variability (HRV), blood pressure variability (BPV),

and baroreflex sensitivity (BRS), provide vital information on the autonomic regulation that occurs throughout pregnancy. HRV, which quantifies the equilibrium between sympathetic and parasympathetic activity, serves as a crucial indication of autonomic function. Fluctuations in heart rate variability (HRV) at various stages of pregnancy might provide insights into how the autonomic nervous system (ANS) adjusts to stresses associated with pregnancy. BPV (Baroreceptor Reflex) and BRS (Baroreceptor Sensitivity) play a crucial role in comprehending the body's capacity to regulate blood pressure effectively even in the face of substantial alterations in circulation. [6,7]

This comparative research seeks to assess autonomic function across several trimesters of pregnancy by the analysis of heart rate variability (HRV), blood pressure variability (BPV), and baroreflex sensitivity (BRS). By clarifying these differences, we may get a deeper understanding of the physiological adjustments of the maternal autonomic nervous system (ANS) and pinpoint possible indicators for difficulties connected to pregnancy. Acquiring this information is crucial for enhancing prenatal care and achieving positive results for both the mother and the child.

Material and Methods

This research was conducted over a one-year period and included 120 pregnant women who were receiving care at the outpatient Department of Physiology, SKMCH, Muzaffarpur, Bihar, India. Women in their first trimester (40), second trimester (40), and third trimester (40) were all provided with an explanation of the operation that will be performed and signed agreement was acquired. Autonomic function tests were conducted on all 120 pregnant women who attended the antenatal (ANC) clinic, each throughout their respective trimester of pregnancy. The physical characteristics recorded for each participant were their age in years and weight in kilogrammes. The CAN WIN–Cardiac Autonomic Neuropathy Analyser was used to examine all individuals. The pregnancy was verified with a urine test that measured the levels of human chorionic gonadotropin. The research participants were provided with a detailed explanation of the study methodology and then obtained informed written permission. Subjects with any current or prior illnesses, such as hypertension, diabetes, cardiovascular abnormalities, a history of poor pregnancy outcomes, a history of previous abortions, or previous caesarean sections, were not included in the research. The participants were categorized into three groups: GROUP I consisted of 40 subjects in the First Trimester, GROUP II consisted of 40 individuals in the Second Trimester, and GROUP III consisted of 40 patients in the Third Trimester. The cardiovascular sympathetic and parasympathetic tests were conducted using the CAN WIN analyzer, a window-based cardiac autonomic neuropathy analyzer with interpretation.

Sympathetic Tests:

1. Blood pressure response to standing /Orthostatic postural hypotension
2. Blood pressure response to sustained handgrip

Parasympathetic Tests:

1. Resting heart rate /minute
2. Heart rate response to deep breathing (Expiratory/ Inspiratory ratio)
3. Heart rate response to Valsalva maneuver
4. Heart rate response to standing (30:15 ratio)

Precautions during measurements:

1. The test was carried out only after the subjects were relaxed
2. Subjects were advised to have light breakfast and empty their bladder before commencing the tests

Statistical Analysis

The acquired data underwent statistical analysis. One-way ANOVA and multiple comparison analyses using SPSS version 22.

Table 1: Demographic characteristics of the groups

	Group I	Group II	Group III
	Mean ± SD	Mean ± SD	Mean ± SD
Age (Years)	22.06 ± 2.78	21 ± 1.66	21.94 ± 2.39
Height (Cm)	155 ± 4.99	155.79 ± 5.38	154.73 ± 4.81
Weight (Kg)	48.14 ± 0.074	47.68 ± 7.14	50.45 ± 8.03
BMI	20.01 ± 2.47	19.62 ± 2.18	21.08 ± 3.18

Table I shows the mean value of age, height, and weight (anthropometric data) in the 3groups (n=120). It revealed statistically insignificant results for the mean value of age and height between the I-Trimester (40) Women's, II-Trimester (40) Women's, III-Trimester (40) Women's. ($p>0.05$). However, the mean value for weight showed statistically significant results between IIIrd trimester group and non –pregnant women and between IIIrd trimester and IInd trimester groups.

Table 2: Parasympathetic tests in the three groups

Para-sympathetic tests	Group I	Group II	Group III
	Mean ± SD	Mean ± SD	Mean ± SD
RHR /min	80.48 ± 10.22	89.82 ± 12.94	94.18 ± 16.74
E : I Ratio	1.26 ± 0.142	1.19 ± 0.107	1.17 ± 0.12
30 : 15 Ratio	1.12 ± 0.160	1.10 ± 0.15	1.08 ± 0.133
Valsalva Ratio	1.56 ± 0.258	1.51 ± 0.25	1.39 ± 0.35

*Statistically significant difference at 5 % level. Abbreviations: HR: Heart Rate, E:I: Expiratory: Inspiratory Ratio and VR: Valsalva Ratio

Table 3: Sympathetic tests in the three groups

SYMPATHETIC TESTS	Group I	Group II	Group III
	Mean ± SD	Mean ± SD	Mean ± SD
OHT	2.91 ± 2.92	4.09 ± 3.38	5.38 ± 3.47
HGT	7.91 ± 7.14	4.54 ± 5.3	10.97 ± 4.2

(HGT: Hand grip Test, OHT: Orthostatic Hypertensive test)

Table 3 shows the group-wise distribution of mean and standard deviation of sympathetic tests in the three groups. As can be seen, women in the three groups showed moderate sympathetic dysfunction.

Table 4: Group wise distribution of ANS interpretation

	Group I (n = 40)	Group II (n = 40)	Group III (n = 40)
Parasympathetic tests	Normal/Mild	Mild	Mild/Moderate
Sympathetic tests	Moderate	Moderate	Moderate
ANS dysfunction	Mild + Moderate	Moderate	Moderate

Table: 4 ANS test interpretation group-wise distribution. Thus, women in group I exhibited normal parasympathetic function, mild to moderate parasympathetic dysfunction, and moderate sympathetic dysfunction. Group II women had mild parasympathetic and moderate sympathetic dysfunction. Group III women had moderate parasympathetic and sympathetic dysfunction. Resting heart rate and expiratory to inspiratory ratio are statistically significant in group II, indicating greater sympathetic and parasympathetic dysfunction.

Discussion

This study observed that pregnant subjects had a significantly lower heart rate response to deep breathing, as measured by deep breathing difference (DBD), which is an indicator of cardiac parasympathetic function. Furthermore, the heart rate response generally decreased as gestation increased, when compared to the control group. This discovery aligns with the observation made by Ekholm EMK, et al, who proposed a multifactorial foundation for it, including several levels of the nervous system, including both peripheral and central processes. [7] During pregnancy, there is a decrease in the parasympathetic input to the heart. This is caused by factors such as lower sensitivity of the baroreceptors, poorer transmission of signals from the vagus nerve to the brain, and changes in the signals sent from the brain to the heart. Pregnant individuals have been shown to have a decrease in the fluctuation of right atrial distension due to reduced pulsatility of blood flow returning from the expanding uterus. This phenomenon may explain the decrease in diastolic blood pressure during pregnancy.

When comparing the autonomic changes in different trimesters of pregnancy, it was found that women in group-I had a mild dysfunction in their autonomic nervous system. Women in group-II showed a moderate dysfunction, while women in group-III demonstrated a moderate dysfunction with mild parasympathetic dysfunction and moderate sympathetic dysfunction. [8] When comparing the three groups, it was found that group II had a greater degree of parasympathetic dysfunction compared to group I. This was supported by statistically significant findings in resting heart rate ($p < 0.01$) and expiratory to inspiratory ratio ($p < 0.05$). In Group II, there was a higher level of sympathetic dysfunction compared to Group I, as shown by a statistically significant outcome in the sustained handgrip test ($p < 0.05$). When comparing parasympathetic tests and sympathetic tests in groups II and III, it was observed that group III had a greater degree of parasympathetic dysfunction compared to group II, based on the mean values. However, there were no statistically significant differences in the parasympathetic tests between group II and group III. Group II had a higher degree of sympathetic dysfunction compared to group III, and the findings of the sustained handgrip test showed a statistically significant difference ($p < 0.01$). The findings suggest that sympathetic activity exhibited a greater decline during the second trimester, a lesser decrease during the first trimester, and the least decrease during the last trimester of pregnancy, approaching levels similar to those before pregnancy. [9] During early pregnancy, there is a general decrease in the constriction of blood

vessels, resulting in the widening of blood vessels throughout the body and an increase in the flexibility of arteries. This may be due to the release of vasopressin, which causes a decrease in blood viscosity and a subsequent decrease in the resistance to blood flow. As a result, there is a decrease in the workload on the heart. Furthermore, a research conducted by Morris et al. provides evidence that heightened nitric oxide (NO) activity significantly contributes to the decrease in systemic resistance during pregnancy. [10] Another significant contributor is the gradual circulation of oestrogens throughout pregnancy, which may directly or indirectly enhance vascular function by increasing the availability of nitric oxide (NO). [11] Additional variables that contribute to this phenomenon include elevated levels of circulating prostaglandins, heightened heat generation by the growing foetus, and the establishment of a low-resistance circulation in the pregnant uterus. As the pregnancy progresses, the growing uterus puts pressure on the aorta and vena cava, which reduces the flow of blood back to the heart and decreases the amount of blood pumped out by the heart. This leads to an increase in sympathetic nervous activity and a decrease in vagal modulation during the third trimester of pregnancy. [12] Silver HM et colleagues observed a reduction in parasympathetic response during pregnancy, which subsequently restores to baseline levels after delivery. [13] Therefore, this kind of research via noninvasive techniques is a very intriguing field, since it poses little danger to the health and well-being of both the mother and the foetus. [14,15]

Conclusion

The research found that cardiac parasympathetic activity reduces heart rate with trimester. The sympathetic activity drops most in the second trimester, less in the first, and least in the final. The body alters physiologically to nurture the foetus, according to all research. These investigations help diagnose cardiovascular functioning abnormalities in pregnancy early, allowing for improved treatment and outcomes.

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