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Research Article

Electrocardiographic variations during three trimesters of normal pregnancy

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ABSTRACT

Background: Electrocardiography can detect the physiological adaptations in the maternal cardiovascular system, but the results should be interpreted with caution as they mislead to the diagnosis of heart disease. This study is undertaken to highlight the effect of normal pregnancy on the electrocardiographic changes during three trimesters, so that it helps to distinguish the normal from that of pathological.
Methods: A total of 150 normal pregnant women, each 50 in three trimesters fulfilling the inclusion criteria were selected for the study. 50 age matched nonpregnant women were selected as control group. A 12 lead ECG was recorded by using ECG machine with special emphasis on mean ECG heart rate, PR interval, frontal plane QRS axis, T wave inversion in lead III & V2, Q waves in LIII & aVF, QTc. All the parameters were analyzed.
Results: The ECG changes observed in our study include, significant increase in mean ECG heart rate, decrease in PR interval, deviation of QRS axis towards left with progression of pregnancy, T wave inversion in lead LIII & V2, presence of Q wave in leads LIII & aVF and QTc was significantly prolonged in second and third trimesters of pregnancy compared to non pregnant group.
Conclusions: The cardiovascular hemodynamic adaptation to pregnancy is a well established fact which was also apparent in our study. It is necessary to understand the normal physiological changes which help in better management of cardiac diseases.

Keywords: Pregnancy, Three trimesters, Electrocardiography.

INTRODUCTION

The major adaptations of the maternal cardiovascular system that progress throughout gestation may unmask previously unrecognized heart disease and result in significant morbidity and mortality. Soon after conception, the maternal cardiovascular system undergoes major adaptation that progress throughout gestation.[1] In the absence of these adaptations, incidence of gestational complications such as fetal growth restriction and pregnancy induced hypertension are known to increase.[2] The cardiovascular changes which occur normally during pregnancy sometimes simulate heart disease.[3] Moreover these alterations in cardiovascular parameters during pregnancy suggest the likelihood of an altered electrocardiogram (ECG) during pregnancy. In support of this view, few previous studies have also demonstrated that some electrocardiographic parameters are indeed altered by the pregnant state.[4,5] ECG changes observed during pregnancy include sinus tachycardia, left axis deviation, ectopic beats, inverted or flattened T waves, a Q wave in lead III and augmented voltage unipolar left foot lead.[6] Hence it is very crucial to understand the cardiovascular alteration during normal pregnancy. This helps to establish a reference for comparison when pathological complications arise during

pregnancy.[7] The present study was set out to determine electrocardiographic changes in normal pregnancy as the electrocardiogram reflects the condition of the heart which in turn is regulated by hemodynamic alterations during normal pregnancy.

METHODS

The present study was a cross sectional study carried out in two Maternity Hospitals, Tirupati, Andhra Pradesh for a period of one year, after obtaining the institutional ethical clearance. 150 women in the age group of 20-35 years who were attending OPD of OBG in maternity hospitals, Tirupati were included in the study group. The study group was in turn divided into 3 subgroups, each comprising of 50 women in first, second and third trimesters of pregnancy. For the study, the first trimester was considered up to the end of 13th week, the second trimester up to the end of 16th week and the third trimester up to the end of 40th week. Control group comprised of 50 apparently healthy age matched non pregnant women.

Written informed consent was taken from each participant after explaining the procedure and the purpose of the study in detail. Then they were subjected for a thorough clinical examination after taking their history and their gestational age was determined.

Inclusion criteria

1. Apparently healthy subjects of Indian origin were included in the study.
2. Health status of the subject was determined by clinical examination and history.
3. Age should be between 20-35 yrs.

Exclusion criteria

1. Women who were taking medication.
2. Women with past history or clinical signs of cardiorespiratory disease.
3. Women with history of diabetes mellitus, hypertension.
4. Women with moderate to severe anemia.
5. Women with any endocrine disorders.
6. Women with preeclampsia/ eclampsia.

The instrument used to record electrocardiograph-CARDIART 6108T manufactured by BPL Electronics ltd. ECG was recorded in supine position after giving 5 minutes of rest to the subject. ECG was recorded in all 12 leads i.e., 3 standard Bipolar Limb Leads I, II & III, 3 Unipolar augmented limb leads aVR, aVL, aVF and 6 precordial leads V1 to V6, by connecting electrodes to left arm, right arm and right leg in supine position. Mean ECG heart rate, PR interval, frontal plane QRS axis, T wave inversion in lead III& V2, Q waves in LIII &aVF were obtained. Corrected QT interval (QTc) was calculated using Bazett's formula;[8] a normal value in females is 0.37 - 0.44 sec.; > 0.44 is prolonged.[9]

The results were expressed as mean±SD for continuous data and number and percentages for categorical data. Data were analyzed by analysis of variance for repeated measures and contingency tables were used to compare findings of results. A 'p' value of <0.05 was considered significant.

RESULTS

A total of 200 women, 50 nonpregnant, 50 women each in first, second and third trimesters of pregnancy were studied. Table 1 shows the mean heart rate of all four groups. Heart rate was expressed in terms of beats per minute. There is a statistically significant increase in mean ECG heart rate from group I to group IV.

Table 1: Mean ECG heart rate.

S.No.	Group	No. of subjects	Mean ± SD	Statistical significance
I	Nonpregnant	50	76.01±4.50	
II	I trimester	50	82.08±10.21	Ivs II p<0.0002; S
III	II trimester	50	89.12±11.12	I vs III p<0.0001; S
IV	III trimester	50	95.75±12.06	IvsIV p<0.0001; S

Table 2 shows that the PR interval decreased in first, second and third trimesters than the nonpregnant women. The decrease is statistically significant in second and third trimesters than in first. There was statistically significant decrease in the QRS axis in all three trimesters than nonpregnant as shown in Table-3.

Table 2: PR interval.

S.No.	Group	No. of subjects	Mean ± SD	Statistical significance
I	Nonpregnant	50	0.142±0.02	
II	I trimester	50	0.136±0.01	IvsII p=0.03; NS
III	II trimester	50	0.13±0.01	I vs III p=0.0001; S
IV	III trimester	50	0.124±0.02	IvsIV p<0.0001; S

Table 4 shows that T wave inversion in lead LIII is also significant in pregnant groups than in nonpregnant. T wave inversion in lead V2 is common in all the trimesters of pregnancy than in the non pregnant women as shown in Table-5.

Table 3: Frontal plane QRS axis.

S.No.	Group	No. of subjects	Mean ± SD	Statistical significance
I	Non pregnant	50	64.4± 5.6	
II	I trimester	50	60.7± 3.4	I vs II p=0.0001; S
III	II trimester	50	56.2± 11	I vs III p<0.0001; S
IV	III trimester	50	45.2± 12.4	I vs IV p<0.0001; S

Table 4: T wave inversion in LIII.

S.No	Group	No. of subjects	T wave inversion in LIII		Statistical significance
			YES (%)	NO (%)	
I	Non pregnant	50	1 (2)	49 (98)	
II	I trimester	50	9 (18)	41 (82)	I vs II p=0.0002;S
III	II trimester	50	10 (20)	40 (80)	I vs III p=0.0001;S
IV	III trimester	50	10 (20)	40 (80)	I vs IV p=0.0001;S
		200	29 (14.5)	171 (85.5)	

Table 5: T wave inversion in V2.

S.No	Group	No. of subjects	T wave inversion in LIII		Statistical significance
			YES (%)	NO (%)	
I	Non pregnant	50	2 (4)	48 (96)	
II	I trimester	50	10 (20)	40 (80)	I vs II p=0.0008; S
III	II trimester	50	12 (24)	38 (76)	I vs III p=0.0001; S
IV	III trimester	50	20 (40)	30 (60)	I vs IV p=0.0001; S
		200	44 (22)	156 (78)	

Table 6 shows that the presence of Q wave in leads LIII & aVF is statistically significant in 2nd and 3rd trimesters of pregnancy than in non pregnant and first trimester. The QTc was significantly prolonged in second and third trimesters of pregnancy compared to non pregnant, but during first trimester the increase is not significant as shown in Table 7.

Table 6: Q in LIII and aVF.

S.No	Group	No. of subjects	T wave inversion in LIII		Statistical significance
			YES (%)	NO (%)	
I	Non pregnant	50	1 (2)	49 (98)	
II	I trimester	50	2 (4)	48 (96)	I vs II p=0.6827; NS
III	II trimester	50	5 (10)	45 (90)	I vs III p=0.0330; S
IV	III trimester	50	11 (22)	39 (78)	I vs IV p=0.0001;S
		200	18 (9)	182 (91)	

Table 7: Mean QTc.

S.No.	Group	Mean ± SD	Statistical significance
I	Non pregnant	0.40± 0.01	
II	I trimester	0.41± 0.05	I vs II p=0.16; NS
III	II trimester	0.45± 0.03	I vs III p=0.0001; S
IV	III trimester	0.47± 0.02	I vs IV p=0.0001; S

DISCUSSION

In the current study, there was a statistically significant increase in the heart rate in 1st, 2nd and 3rd trimesters of pregnancy as compared to non-pregnant women. The heart rate increased progressively throughout the pregnancy and reached a maximum during third trimester. The increase in heart rate was due to a decrease in vagal baroreflex as well as a decrease in parasympathetic tone.[10] The increase in heart rate mainly during third trimester of pregnancy compensates for the fall in the stroke volume resulting from caval compression.[11] This result correlates with many previous studies by Voss A et al., Katz et al., Burwell et al. and Stein et al.[10,12-14]

In the study by Oppen V et al. the mean heart rate increased gradually from 10-18 weeks gestation to 34-42 weeks gestation.[2] Voss A et al. showed that all measures of nonlinear dynamics of heart rate variability showed significant changes between pregnant and nonpregnant women. Katz et al. found that the heart rate increase was evident by the first trimester and the trend continued and reached a peak during the third trimester. In the study by Akinwusi PO et al. the ECG heart rate reached statistical

significance between the pregnant and nonpregnant groups.[15]

In the current study, PR interval was shown to be decreased in all the three trimesters than nonpregnant controls. However, the decrease is not statistically significant in first trimester. In the study by Carruth et al., they found that the mean PR interval was shorter at third trimester when compared to first and second trimesters of pregnancy & it was statistically significant.[16] Similar results to our study were observed by Sharad Koleet al.[5] In their study, PR interval exhibited a significant reduction in the mean values in second and third trimesters when compared with controls and first trimester group. But Nandini et al. observed statistically significantly decreased PR interval in first, second and third trimesters of pregnancy as compared to control group.[17] The decrease in PR interval during pregnancy could be due to shortening of A-V conductance and the resultant tachycardia that accompanies pregnancy.[5]

The QRS axis is a measure of the overall direction of depolarization of the ventricles. In our study, there was statistically significant decrease in the QRS axis in all the three trimesters of pregnancy than nonpregnant. Lechmanova et al. observed a change of the electrical heart field resulting from the changed spatial position of the heart during last trimester of pregnancy in healthy women.[20] Carruth JE et al., confirmed left axis deviation in the third trimester in their study.[16] Singh AD et al. reported that electrical axis of +60º corresponding to semi vertical heart position was commonest in pregnant women and they also observed left axis deviation during pregnancy. In their study the change in electrical axis was attributed to the raising of diaphragm as pregnancy advances.[21] Results similar to our study were also observed by Sunitha et al. in their study. They found significant decrease in the QRS axis in pregnant group when compared to controls.[22]

In our study, T wave inversion in lead III and in V2 appeared more frequent in the pregnant women than in non pregnant. This has been reported in previous studies[3,15,18] and is attributable to the increased work load on heart due to temporary increased blood volume during pregnancy which may cause a temporary ischemia, represented by T wave inversion.[3] Misra J et al observed a negative T wave in lead III in 70% subjects of normal pregnancy and in almost all the chest leads. In the study by Akinwusi PO et al. T wave inversion in lead III ± any other lead was commoner in the pregnant group than the controls.[15] Veille JC et al. observed T wave inversion in V2 more frequent in pregnant than in nonpregnant women.[18]

In the present study, presence of Q wave in lead III and aVF is significant in second and third trimesters of pregnancy when compared to first trimester and non pregnant groups. These changes may be either due to an increase in the circulating vasopressor agents or may reflect diaphragmatic changes that have been associated with pregnancy. The frequent occurring of Q wave during pregnancy when compared to normal non pregnant women may be due to altered position of the heart.[19] Misra J et al. reported prominent Q wave in 6.66% of the cases studied. Veille et al. found that subjects “late” in pregnancy had significantly fewer Q waves in II, III and aVF than nonpregnant group did. Carruth JE et al. noticed that the development of Q wave was frequent in pregnant women.[16] Singh AD et al. noted Q wave of 1 mm or more in 48% of the cases in their study.[21]

Even though QT interval represents time from onset of ventricular depolarization to the completion of repolarization, since it varies with heart rate, corrected QT interval is usually used.[23] In the present study, there was a statistically significant increase in QTc interval in the 2nd and 3rd trimesters of pregnancy when compared to non pregnant group. In 1st trimester of pregnancy the increase is not statistically significant. An increase in the QTc interval may be due to increase in heart rate. This could be linked to changes in ventricular depolarization and repolarization patterns during pregnancy. This must be considered as a complex consequence of changes in the various regulatory mechanisms occurring during normal pregnancy.[20] Similar reports were given in previous studies by Carruth et al. and Lechmanova et al.[16,20] Lechmanova et al. in their study found an increase in QT interval as well as prolongation of QTc interval during late pregnancy. These changes were attributed to changed spatial arrangement of chest organs during pregnancy, changed electrical properties of the myocardium due to changed sympathetic and hormonal modulation (epinephrine, progesterone) of the electrical heart activity during pregnancy. They also opined that this prolonged QT and QTc intervals should be interpreted simply as “an unspecific sign of changed course of repolarization”.[20,5]

In our study, ECG changes like reduction in QRS axis, shortening of PR interval, T wave inversion in lead III and V2, prominent Q waves in lead III and aVF, prolonged QTc were observed in pregnant women than in nonpregnant women. Although minor electrocardiographic changes were found at rest, these should be considered normal unless associated with significant symptoms. The interpretation of ECG during the antenatal period should be done with caution. Further studies should be done, especially longitudinal studies to provide more information about the changes that take place in a particular woman during the entire period of pregnancy and their reversal after delivery.

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