

## VARIATIONS IN ELECTRICAL ACTIVITY OF THE HEART AS THE PREGNANCY PROGRESSES

**Background:** Pregnancy is a physiological condition that brings a considerable alteration in hemodynamic activity of the maternal heart. It is very important to understand the cardiac functioning of maternal heart during normal pregnancy because apart from obstetric causes, cardiac disorders are the main cause of mortality in females. Study of electrical activity of the heart is a simple noninvasive and cost effective method which can also raise alarm about the pathological changes in the cardiac function.

**Aims & Objective:** To study the intervals of Electrocardiogram (ECG) in pregnant women and to compare the same with healthy non pregnant women.

**Materials and Methods:** A total of 223 females fulfilling the inclusion criteria were recruited for the study. They were divided into four groups - nonpregnant/control group (n=30), 1<sup>st</sup> trimester (n=36), 2<sup>nd</sup> trimester (n=64) and 3<sup>rd</sup> trimester (n= 93). ECG was recorded in lead II. Heart rate, PR, QT interval and QTc were also calculated. These parameters were compared between the groups using one way ANOVA test. A p value of less than 0.05 was considered as significant.

**Results:** An increase in heart rate and QTc interval and decrease in PR interval was observed in pregnant women when compared with the heart rate of nonpregnant females. This was statistically insignificant when compared between controls and 1<sup>st</sup> trimester. However a significant change was observed between control group and 2<sup>nd</sup>/3<sup>rd</sup> trimester groups. This change was also observed significantly within the pregnant groups when compared with each other.

**Conclusion:** The cardiovascular hemodynamic adaptation to pregnancy is a well-established physiological fact which was also apparent in this study. Further we noticed a significant change in electrical activity in pregnancy in terms of PR, QT and QTc intervals. These changes became more significant after 1<sup>st</sup> trimester and peaking during the 3<sup>rd</sup> trimester.

**Key Words:** Heart Rate; PR Interval; Pregnancy; QTc

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### INTRODUCTION

Pregnancy is a normal healthy condition and also the most common altered physiologic state to which females are subjected to. It places a burden on the cardiovascular system. This burden is of the magnitude that can be compensated by bringing the reserve capacity of cardiovascular system (CVS) into action in a normal woman. However these compensatory mechanisms are both physiological and mechanical in nature.<sup>[1]</sup> Cardiovascular changes such as increase in heart rate, cardiac output and intravascular volume have been observed during pregnancy.<sup>[2]</sup> The physiological changes during pregnancy facilitate the adaptation of the cardiovascular system to the increased metabolic needs of the mother enabling adequate delivery of oxygenated blood to the peripheral tissues and to the fetus.<sup>[3]</sup> Particularly in first two trimesters a 30% to 50% increase in cardiac output was observed, which begins to rise gradually at 8 to 10 weeks of gestation and peaks at approximately 25 to 30 weeks 'of gestation.<sup>[4]</sup> Thus the pregnancy state provides an excellent opportunity to study the important physiologic and hemodynamic

changes in the CVS.

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.<sup>[5,6]</sup> 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 the augmented voltage unipolar left foot lead.<sup>[4]</sup> 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.<sup>[7]</sup> The fact that cardiovascular disease ranks as the prime indirect cause of maternal death as well as the most common cause of maternal death overall<sup>[6]</sup> further necessitates a detailed study. Hence we took up the present study to assess the changes in electrical activity of heart in the three trimesters of normal pregnancy and by comparing the same in non-pregnant women, by using PR and QT intervals of ECG.

## MATERIALS AND METHODS

The present study was a cross sectional study carried out at Government Medical College, Miraj, Maharashtra, after obtaining the institutional ethical clearance. A total of 193 pregnant women in the age group of 19-35 years, attending Obstetrics and Gynaecology department for antenatal care were recruited irrespective of their gestational period. Then they were subjected for a thorough clinical examination after taking their history and their gestational age was determined. The women who were taking medication, who were experiencing symptoms or past history of cardio respiratory disease, hypertension, diabetes mellitus, ischemic heart disease, thyroid disorders, anaemia, preeclampsia/eclampsia, or any condition likely to affect the cardiovascular system and hence the ECG were specifically excluded from the study. Thirty age matched healthy non pregnant were selected from the general population and were considered as controls.

Written informed consent was taken from each participant after explaining the detailed procedure and purpose of the study. Standing height was measured without foot wear, with the subjects back to a wall and with both heels placed together and touching the base of the wall. Weight was recorded with minimum reading of 0.5 kg and same apparatus was used throughout the study. The participants were made to relax and be comfortable prior to the tests. Then the subjects were asked to assume supine position and to take rest for 15 minutes. Then ECG leads were connected and electrocardiogram was recorded in lead II with paper speed at 25 mm/sec for a period of one complete minute. Cardiart 108 (make BPL) was used for ECG recording. Heart rate (HR), PR and QT interval was calculated from ECG recording. Corrected QT interval (QTc) was calculated using Bazett's formula. Based on the gestational period pregnant women were divided into three groups as 1<sup>st</sup> trimester, 2<sup>nd</sup> trimester and 3<sup>rd</sup> trimester.

**Statistical Analysis:** The mean values of all the parameters recorded were analysed by using one way ANOVA and comparison between controls and pregnant women in three different stages of gestation was obtained by using post hoc Tukey's test. A p value less than 0.05 was considered as significant. Statistical software package SPSS version 17 was used for the analysis.

## RESULTS

Total 193 pregnant women, who were recruited, were divided into three groups based on gestational stage - 36 were considered in the group of 1st trimester, 64 pregnant ladies were belonging to 2nd trimester and the remaining 93 individuals constituted the group of 3rd trimester. Thirty age matched nonpregnant women were considered as controls. The mean values of height in centimeters and weight in kilograms (table 1) calculated in all the four groups were compared by one way ANOVA and did not show any significant differences between the study groups. The mean value of QT interval between the groups was insignificant, however the parameters recorded such as HR, PR interval and QTc (table 2) revealed a significant value on comparison across the groups. Hence the post hoc Tukey test was performed to analyse the significant differences between control and three groups of pregnant women distributed over three trimesters. (Table 3)

**Table-1: Anthropometric Data**

	Control (n=30)	1 <sup>st</sup> trimester (n= 36)	2 <sup>nd</sup> trimester (n=64)	3 <sup>rd</sup> trimester (n=93)
Height	149.67 ± 6.42	151.53 ± 5.98	149.31 ± 5.71	150.02 ± 5.36
Weight	46.5 ± 5.9	45.61 ± 3.89	45.16 ± 5.54	46.98 ± 5.28

**Table-2: Heart rate and ECG intervals in controls and pregnant women**

	Controls	1 <sup>st</sup> trimester	2 <sup>nd</sup> Trimester	3 <sup>rd</sup> Trimester	F value	P value
HR	80.93 ± 5.34	86.17 ± 13.34	95.63 ± 13.96	101.88 ± 11.22	31.07	0.000
PR Interval	0.143 ± 0.03	0.143 ± 0.02	0.126 ± 0.02	0.12 ± 0.01	21.28	0.000
QT Interval	0.334 ± 0.02	0.332 ± 0.02	0.342 ± 0.03	0.341 ± 0.02	1.76	0.16
QTc	402.63 ± 27.61	400.17 ± 32.97	431.77 ± 24.88	443.39 ± 24.91	32.74	0.000

**Table 3: probability (p) values when compared between two groups by Post Hoc Tukey's test (HSD=0.05)**

	1	2	3	4	5	6
HR	0.282	0.000	0.000	0.001	0.000	0.007
PR Interval	1.0	0.000	0.000	0.000	0.000	0.216
QTc	0.982	0.000	0.000	0.000	0.000	0.037

1: Control Vs 1<sup>st</sup> trimester; 2: Control Vs 2<sup>nd</sup> trimester; 3: Control Vs 3<sup>rd</sup> trimester; 4: 1<sup>st</sup> trimester Vs 2<sup>nd</sup> trimester; 5: 1<sup>st</sup> trimester Vs 3<sup>rd</sup> trimester; 6: 2<sup>nd</sup> trimester Vs 3<sup>rd</sup> trimester

## DISCUSSION

Pregnancy being a normal physiological process induces wide spread adaptation in the mother. During pregnancy huge quantity of energy is required for heart to carry out the normal functioning even during rest. This entails significant change in the cardiovascular and respiratory physiology. Changes in the functioning of the heart will lead to change in the electrocardiographic pattern. Although electrocardiographic pattern is same for all

population the electrocardiographic standard on the other hand is not same for all. This standard for ECG changes with age, sex, weight, obesity<sup>[8]</sup> and also in pregnancy.<sup>[5]</sup> Hence in the present study an attempt is made to find out electrocardiographic trends in asymptomatic, healthy normal pregnant subject within a age group of 19 to 35 years and to compare the same with the different gestational age in terms of trimesters and also with age matched non pregnant women. The subjects and controls of this study were well matched for age, height and weight.

In the current study heart rate increased progressively throughout the pregnancy and reached a peak during the third trimester and this finding shows consonance with many previous studies.<sup>[9-11]</sup> This increased heart rate may be because of hormonal factors like increased levels of HCG in early stages of pregnancy<sup>[12]</sup> and later it may be because of increased left atrial diameter and sympathetic activation that can also lead to sinus-node remodeling.<sup>[2]</sup> This progressive rise in heart rate with increasing duration of gestation serves aspects like increased demand for oxygen, increase in blood volume, boost the cardiac output and increase in venous return. Cardiac output increases 30% to 50% from 4 L to 6 L/min, particularly during the first two trimesters. This increase is primarily a result of a 20% to 50% increase in stroke volume. Furthermore an estrogen-mediated increase in myocardial alpha-receptors produces an increase in heart rate of about 10 to 20 beats/min.<sup>[4]</sup> The peaking in heart rate mainly during third trimester of pregnancy compensates for the fall in the stroke volume resulting from caval compression<sup>[13]</sup> and there by maintaining the cardiac output.

PR interval exhibited a significant reduction in the mean values in second and third trimesters when compared with controls and first trimester group. Our results are in concordance with the observations of Nandini et al.<sup>[13]</sup> The only exception is for significantly reduced PR interval in first trimester which was not observed in our study. This may be because of insignificant increment in heart rate between controls and 1<sup>st</sup> trimester group. Carruth JE et al.<sup>[5]</sup> in their study found a slightly shorter mean PR interval in the third trimester compared to first and second trimester. The decrease in PR interval during pregnancy could be due to shortening of A-V conductance and the resultant tachycardia that accompanies pregnancy.<sup>[13]</sup> However the mean values of PR intervals in all groups in our study were within the normal limits which was similar to the finding of Akinwusi PO et al.<sup>[14]</sup>

The present study did not find any significant difference in QT interval between pregnant and nonpregnant women and also between various trimesters of pregnant women. 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.<sup>[15]</sup> In Our study QTc is progressively increased during pregnancy but this increase in QTc is not statistically significant during first trimester of pregnancy. However we noticed a significant increase in QTc from 2<sup>nd</sup> trimester onwards. The increase in 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.<sup>[16]</sup> Lechmanova M et al.<sup>[17]</sup> 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”.

## CONCLUSION

Cardiovascular adaptations related to pregnancy were also observed in the electrical activity of the heart. A significant reduction in PR interval and an increased QTc were observed in pregnant women. These changes become more prominent after 2<sup>nd</sup> trimester onwards and reach a peak during the 3<sup>rd</sup> trimester. These changes can be considered as a part of normal physiological compensatory mechanism that takes place during pregnancy. Hence knowledge of these ECG findings can obviate the chances of misinterpretation. A longitudinal study may provide more information about the change that takes place during the course of pregnancy in the same women. Further similar studies done on pregnant women with cardiovascular disorders in electrical activity such as long QT syndrome may throw more light in this field.

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