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Occurrence of Q wave, QTC interval and QRS frontal axis during different trimesters of Pregnancy – A cross sectional study

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KEYWORDS

Q wave,
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A B S T R A C T

In pregnant women, large number of local and systemic changes are known to occur. These changes will continue throughout pregnancy especially cardiovascular changes. Electrocardiography is one of the simplest techniques used to detect ischemic heart diseases, hypertensive heart diseases & asymptomatic arrhythmias. We included 150 pregnant women, 50 in each trimester and were compared with 50 age matched non pregnant women. ECG was recorded in all 12 leads. The values were expressed as Mean + SD and Z – Test was used for comparison between control and study group. Categorical data was analyzed by Chi – square test. A 'p' value of 0.05 or less was considered as statistically significant. a statistically significant increase in QTc interval was observed.An increase in the QTc interval may be due to tachycardia. QRS Frontal axis showed a statistically significant decrease in 1st, 2nd and 3rd trimesters ($p<0.001$) of pregnancy when compared to non pregnant women. With increase in gestational age, position of heart changes from vertical to intermediate indicating that heart shifted to left with increase in gestational period. Occurrence of Q wave in lead III showed a statistically significant increase in 2nd ($p<0.05$) and 3rd trimesters ($p<0.001$) when compared to 1st trimester of pregnancy and control 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.

Introduction

Pregnancy is considered to be the most beautiful and enriching experience in the life of a woman. It is characterized by profound changes in the function of virtually every regulatory system in the human body.

In pregnant women, large number of local and systemic changes are known to occur. These changes will continue throughout pregnancy[1] especially cardiovascular changes such as increase in heart rate, cardiac output and intravascular volume[2].

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[3]. In the absence of these adaptations, incidence of gestational complications such as fetal growth restriction and pregnancy induced hypertension are known to increase.[4]

Heart diseases contribute significantly to maternal mortality throughout the world. Although heart diseases rarely occur during pregnancy, it is a fact that greater number of women with known or potential heart diseases are becoming pregnant[5]. Hemodynamic changes during pregnancy play a major role in the induction of arrhythmias. The increased incidence of arrhythmias during pregnancy is also reported.[6]

Heart diseases during pregnancy remain a serious problem. One of the important tools for the diagnosis of heart diseases is recording electrocardiogram. In order to make use of it accurately, knowledge about ECG changes during normal pregnancy is a must.[7] Electrocardiography is one of the simplest techniques used to detect ischemic heart diseases, hypertensive heart diseases & asymptomatic arrythmias.[8]

Materials and Methods

A cross sectional study was conducted in the Department of Physiology, Shri B.M.Patil Medical College, Hospital and Research Centre, Bijapur. Duration of the study was one year.

The study was undertaken to determine the ECG changes in 1st, 2nd & 3rd trimesters of pregnancy. The observations were compared with age matched healthy non pregnant women.

Method of Collection of data

Study Group: 150 pregnant women in the age group of 20-35yrs who were attending the OPD of OBGy of Shri B.M. Patil Medical College were included in the study group. The study group was in turn divided into 3 subgroups. Each subgroup comprising of 50 women in first, second and third trimesters of pregnancy.

Control Group: It was comprising of another apparently healthy age matched 50 non pregnant women.

The nature and purpose of the study were explained to the subjects who had volunteered for the study. From each participant an informed consent was obtained. A thorough physical & systemic examination of each subject was done (in particular, cardiovascular and respiratory system). Recordings were taken during morning hours between 9 am to 12 Noon.

Inclusion Criteria

- Apparently healthy subjects of Indian origin were included in the study.
- The apparent health status of the subject were determined through thorough clinical examination and history taking.

Exclusion Criteria

1. Subjects with history or clinical signs of cardiovascular diseases.
2. Subjects with acute respiratory infection in the previous three months.

3. Subject with history of diabetes mellitus, hypertension.
4. Subjects with history of tobacco consumption in any form.
5. Subjects with history of alcohol intake.
6. Subjects with any endocrine disorders.
7. Subjects with obesity.
8. Subjects with moderate to severe anemia.

Following parameters were recorded in each subject

Height (in centimeters), Weight (in kilograms), Body surface area in square meters using Dubois nomogram, Body Mass Index in kilograms/ meter using Quetelet Index, Resting pulse rate was expressed as bpm, Blood pressure (in mm Hg). It was measured by mercurial sphygmomanometer (diamond make) by palpatory and auscultatory method.

Recording of Electrocardiogram 22

ECG was recorded after giving 5 minutes of rest to the subject to allay anxiety. 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: VI to V6, by connecting electrodes to left arm, right arm, left leg and right leg in supine position.

Statistical Analysis

The results were expressed as Mean + SD for continuous data and number and percentages for categorial data. Z test was used for comparison between control and study groups and Z test was used for comparison within the study group. Categorial data was analysed by Chi- square test.

A ‘p’ value of 0.05 or less was considered as statistically significant.

Results and Discussion

QTc Interval

QTc interval (sec) in controls, pregnant women in 1st, 2nd and 3rd trimesters were 0.38 + 0.01, 0.39 + 0.01, 0.40 + 0.01 and 0.41 + 0.01 respectively (Table 2). QTc interval showed a statistically significant increase 1st, 2nd and 3rd trimester of pregnancy when compared to control group ($p< 0.001$) (Table 3). Similarly, a statistically significant increase in QTc interval was observed in 2nd and 3rd trimester ($p< 0.001$) of pregnancy when compared to 1st trimester and also in 3rd trimester ($p< 0.001$) of pregnancy when compared to 2nd trimester

QRS Frontal axis

QRS Frontal axis (degrees) in control, pregnant women in 1st , 2nd and 3rd trimesters were 64.56 + 7.66, 60.48 + 11.05, 55.70 + 12.61 and 45.4 + 22.54 respectively (Table 2). QRS Frontal axis showed a statistically significant decrease in 1st, 2nd and 3rd trimesters ($p<0.001$) of pregnancy when compared to non pregnant women (Table 3). Similarly, a statistically significant decrease in QRS frontal axis was observed in 2nd and 3rd trimesters ($p<0.001$) when compared 1st trimester and 3rd trimester when compared to 2nd trimester of pregnancy ($p<0.001$)

ST segment

In the present study, we observed ST segment depression in 2nd and 3rd trimesters of pregnancy i.e 4 subjects in 2nd trimester and 6 subjects in 3rd trimester. None of subjects in control group and in 1st trimester of pregnancy showed ST segment depression. There was no statistically significant difference between control and study groups or within the subgroups of study group ($p>0.05$).

Q wave

Occurrence of Q wave in limb leads

Lead I

Control: Q wave was noted in 6% of the subjects.

1st Trimester: Q wave was noted in 4%, **2nd Trimester:** Q wave was noted in 8% and
3rd Trimester: Q wave was noted in 10% of the subjects

Occurrence of Q wave in lead I showed a slight increase in 2nd and 3rd trimesters of pregnancy when compared to 1st trimester of pregnancy and control group. But, there was no significant statistical difference between the groups ($p>0.05$), (Table 1).

Lead II

Control: Q wave was noted in 26% of the subjects.

1st Trimester: Q wave was noted in 32% , **2nd Trimester:** Q wave was noted in 44% and **3rd Trimester:** Q wave was noted in 52% of the subjects.

Occurrence of Q wave in lead II showed a statistically significant increase in 2nd ($p<0.05$) and 3rd trimesters ($p<0.001$) when compared to 1st trimester of pregnancy and control group (Table 1).

Lead III

Control: Q wave was noted in 32% of the subjects.
1st Trimester: Q wave was noted in 36%, **2nd Trimester:** Q wave was noted in 48% and **3rd Trimester:** Q wave was noted in 58% of the subjects

Occurrence of Q wave in lead III showed a statistically significant increase in 2nd ($p<0.05$) and 3rd trimesters ($p<0.001$) when compared to 1st trimester of pregnancy and control group (Table 1).

Pregnancy is a normal physiological process. It induces widespread circulatory adaptations in the mothers. The pregnancy induced changes in the cardiovascular system develop primarily to meet the increased metabolic demands of mother & fetus.

Both structural and functional changes are known to occur in the heart and vessels due to pregnancy. Ventricular dimensions, heart rate, cardiac output, vascular compliance and capacitance will increase whereas peripheral resistance and blood pressure decrease during pregnancy. Many of these changes are induced by gestational hormonal milieu which influences vessel structure, basal tone and reactivity via receptors for chorionic gonadotropin, estradiol and progesterone located in vascular endothelium and smooth muscle.[9]

Despite the increased work load on the heart during gestation, the healthy pregnant women have no impairment of cardiac reserve. An understanding of these changes and the mechanism involved would be helpful in deciding on the optimal management of pregnant women with preexisting cardiovascular diseases as well as potentially useful in the prevention of gestational complications associated with inadequate maternal hemodynamic adaptation.

Electrocardiography is one of basic tools in the investigation of cardiovascular diseases. The electrocardiogram during normal pregnancy may show wide variation from the normal accepted. These variations may

be due to the changed spatial arrangement of the chest organs as well as changed electrical properties of the myocardium.These changes are inturn due to sympathetic and hormonal modulation of cardiac electrica.

Q wave

In the present study, there was a statistically significant increase in occurrence of Q wave in the 2nd and 3rd trimesters when compared to 1st trimester of pregnancy and the control group.

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.[10] The frequent occurring of Q wave during pregnancy when compared to normal non pregnant women may be to due altered position of the heart.[11]

Similar findings were reported by Misra J et al [12], Veille JC et al[13], Carruth JE et al [14] & Singh AD[11], in their studies.

QRS Complex

QRS Complex measurement had no statistically significant difference in duration either when compared between the study and the control groups, nor between the subgroups within study groups.

ST segment

In the present study, ST segment depression was noticed in 4 subjects in 2nd trimester and 6 subjects in the 3rd trimester of pregnancy. There was no change in ST segment in the subjects of control group and 1st trimester of pregnancy. There was no statistically significant difference between the control and the study groups or between subgroups within study group.

One of the causes for ST segment depression during pregnancy may be due to electrolyte imbalance such as hypokalaemia as a result of persistent vomiting.[15]

It has been suggested that transient ST segment depression is associated with anxiety which may be a provoking stimulus and that can be attributed to an endogenous hypersensitivity. One of the mechanisms by which adrenaline induces hypersensitivity is by increasing oxygen demand by the increased muscular action and coronary dilation. Anxiety might be accompanied by an increase in circulating humoral agents which would directly affect myocardial electrical activity .[16]

Our findings are in accordance with the observations made by Boyle DM et al [7], Veille JC et al[13], Oram S et al[15], Singh AD et all[11] in their study.

QT Interval

In our study,there was no statistically significant increase or decrease in the QT interval when compared between the control and study groups or within the study group.

QTc Interval

QTc Interval in electrocardiogram reflects the time taken for depolarization and repolarization in the ventricular myocardium. The QT interval when corrected for heart rate is QTc.

It must be emphasized that the surface electrocardiographic QTc interval reflects complex and interrelated aspects of cardiac electrophysiology, cardiac geometry, torso

shape, tissue impedance and biological signal processing.

In the present study, it was found that there was a statistically significant increase in QTc interval in 1st, 2nd and 3rd trimesters of pregnancy when compared to control group. There was also a statistically significant increase in QTc interval in 2nd and 3rd trimesters when compared to 1st trimester of pregnancy and also in the 3rd when compared to 2nd trimester of pregnancy.

It is first necessary to determine the normal range of QTc interval in healthy pregnant women. It seemed possible that the altered circulatory dynamics during pregnancy might have some effect on its duration. It appears that the physical and emotional stress during 9 months of pregnancy may be a factor in triggering heart rhythm disorders in some vulnerable women.[16]

An increase in the QTc interval may be due to tachycardia. They must be considered as a complex consequence with changes in regulatory mechanisms during normal pregnancy[17].
Similar reports were given by Lechmanova et al[17], Ozmen N et al[2], Carruth JE et al[14], Oram S et al[15] in their studies.

QRS Frontal axis

In the present study, QRS axis showed a statistically significant decrease in the 1st, 2nd and 3rd trimesters of pregnancy when compared to non pregnant women. There was also a statistically significant decrease in the 3rd trimester when compared to 1st and 2nd trimester of pregnancy.

With increase in gestational age, position of heart changes from vertical to intermediate indicating that heart shifted to left with increase in gestational period.

The change in the electrical axis may be due to raise in the diaphragm during pregnancy.[11] The changes in the left ventricular size and mass and associated increased volume may cause the apical impulse to be displaced to the left. Elevation and rotation of the heart resulting from the enlarging uterus [18] and left axis shift in early pregnancy can be explained from the fact that there is an increased blood volume which in turn causes left ventricular load.[12]
Similar findings were also reported from Singh AD et al[11], Misra J et al[12], Lechmanova M et al[19] & Carruth JE et al[14] in their studies.

Table.1 Chi Square Test for association of occurrence of Q wave in Std Limb Leads between the study and the control groups

Limb leads	Occurrence of Q wave			
	Chi Square Value	Control & 1st Trimester	Control & 2nd Trimester	Control & 3rd Trimester
I	0.82 p>0.05	NS	NS	NS
II	15.7 P<0.001	2.32 p>0.05	8.12* P<0.05	16.12*** P<0.001
III	13.5 P<0.05	4.32 p>0.05	9.23* P<0.05	17.3*** P<0.001

p>0.05: Not Significant, *p: <0.05: Significant,
** p: <0.01: Highly significant, *** p: <0.001: Very highly significant.

Table.2 Mean ± SD and Range of QRS Complex, QT Interval, QTc Interval and QRS frontal axis in subjects of Control and Study groups

Parameters	Control		1st Trimester		2nd Trimester		3rd Trimester	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
QRS Complex(sec	0.08 ± 0.01	0.06 - 0.1	0.08 ± 0.01	0.06 - 0.08	0.08 ± 0.01	0.06 - 0.1	0.08 ± 0.01	0.04 - 0.08
QT Interval (sec)	0.35 ± 0.02	0.32 - 0.36	0.35 ± 0.02	0.32 - 0.36	0.35 ± 0.02	0.32 - 0.36	0.36 ± 0.01	0.32 - 0.36
QTc Interval (sec)	0.38 ± 0.01	0.34 - 0.40	0.39 ± 0.01	0.35 - 0.42	0.40 ± 0.01	0.37 - 0.42	0.41 ± 0.01	0.37- 0.42
QRS frontal axis (degree)	64.56 ± 7.66	48 - 80	60.48 ± 11.05	26 - 82	55.70 ± 12.61	22 – 82	45.4 ± 22.54	-3 - 80

Table.3 Test of Significance for QRS Complex, QT Interval, QTc Interval and QRS frontal axis using Z Statistics between Control and Study groups

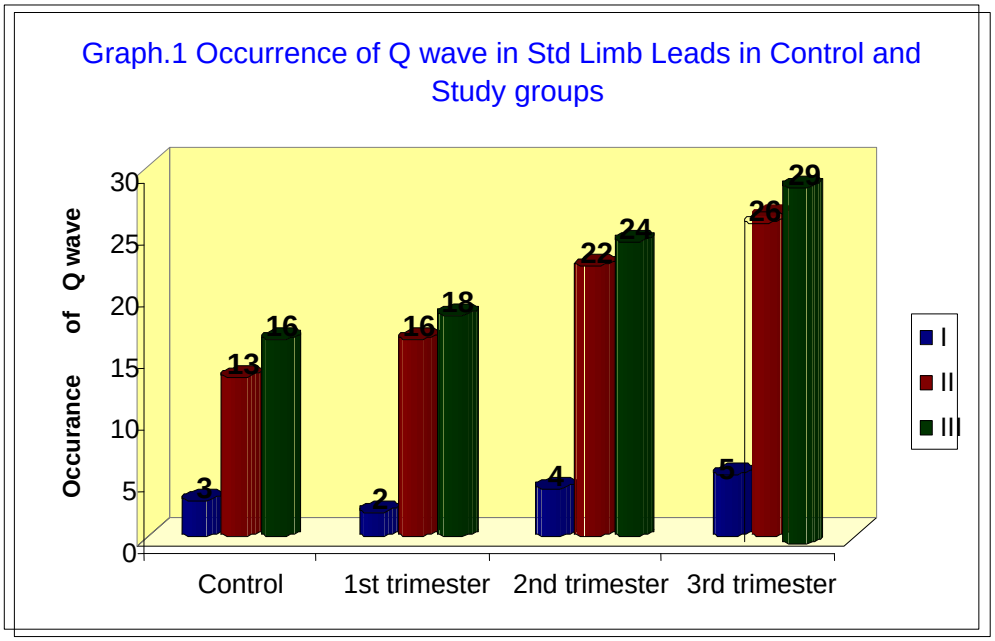
Parameters	Control & 1st Trimester		Control & 2nd Trimester		Control & 3rd Trimester	
	Z-Value	P-Value	Z-Value	P-Value	Z-Value	P-Value
QRS Complex (sec)	1.83	0.067	1.62	0.105	1.69	0.091
QT Interval (sec)	0.84	0.401	0.87	0.384	1.05	0.293
QTc Interval (sec)	3.96	< 0.0001***	4.44	< 0.0001***	3.88	< 0.0001***
QRS frontal axis (degree)	2.14	0.032*	3.95	<0.0001***	4.21	<0.0001***

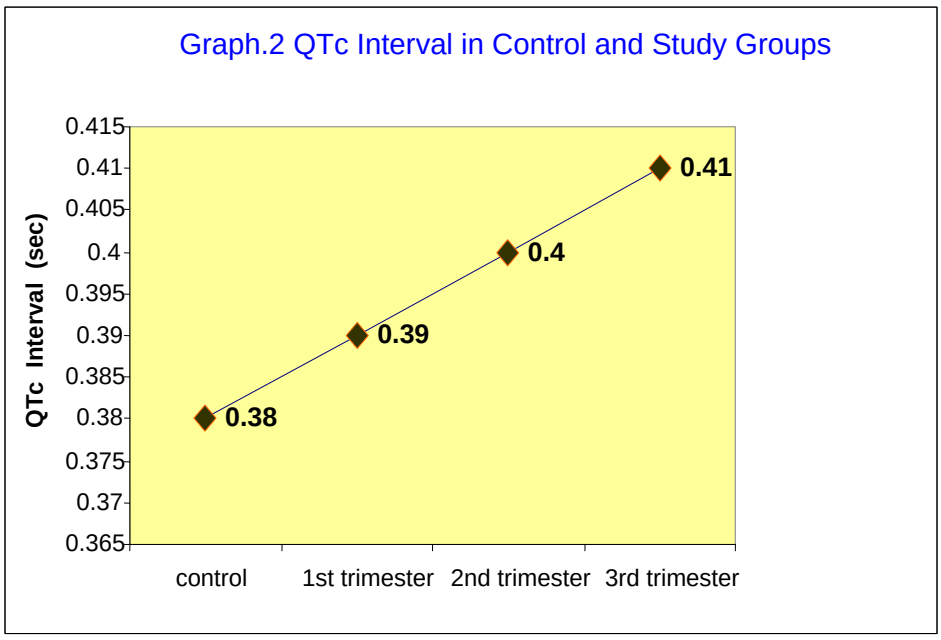
p>0.05: Not Significant, *p: <0.05: Significant,
** p: <0.01: Highly significant, *** p: <0.001: Very highly significant

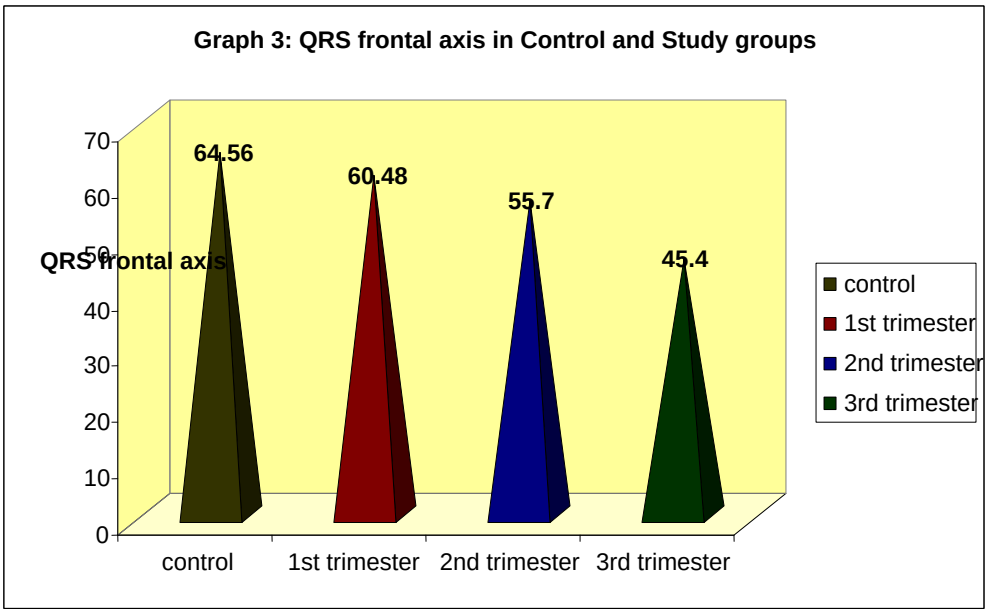
Table.4 Test of Significance for QRS Complex, QT Interval, QTc Interval and QRS frontal axis using Z Statistics within the subgroups of Study group

Parameters	1st & 2nd Trimesters		1st & 3rd Trimesters		2nd & 3rd Trimesters	
	Z-Value	P-Value	Z-Value	P-Value	Z-Value	P-Value
QRS Complex (sec)	1.62	0.105	0.21	0.833	0.19	0.849
QT Interval (sec)	0.87	0.384	2.21	0.027	2.16	0.030
QTc Interval (sec)	4.44	0.0001***	6.39	0.0001***	3.88	0.0001***
QRS frontal axis (degree)	1.95	0.051	6.36	0.0001***	4.08	0.0001***

p>0.05: Not Significant, *p: <0.05: Significant,
** p: <0.01: Highly significant, *** p: <0.001: Very highly significant


Graph.1 Occurrence of Q wave in Std Limb Leads in Control and Study groups
Occurance of Q wave
30
25
20
15
10
5
0
3
13
16
2
16
18
4
22
24
5
26
29
Control
1st trimester
2nd trimester
3rd trimester
I
II
III


Graph.2 QTc Interval in Control and Study Groups
QTc Interval (sec)
0.415
0.41
0.405
0.4
0.395
0.39
0.385
0.38
0.375
0.37
0.365
0.38
0.39
0.4
0.41
control
1st trimester
2nd trimester
3rd trimester



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