Original Article

DOI: 10.7860/JCDR/2016/17774.7507

Maternal Myocardial Performance in Second Trimester of Pregnancy With Iron Deficiency Anaemia

Physiology Section

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ABSTRACT

Introduction: Anaemia affects various organs in body including the heart. In anaemia, oxygen carrying capacity of blood decreases. Iron depletion and the amount of stored iron are reduced in iron deficiency anaemia which limits red cell production. However, the studies which show the effect of anaemia on myocardial function during pregnancy are few in India.

Aim: To study the effect of iron deficiency anaemia on myocardial function by ECG during second trimester of pregnancy and to compare ECG changes with normal pregnant women in second trimester.

Materials and Methods: The study was conducted at antenatal OPD between Oct 2014 to Jul 2015. Hundred pregnant women were selected and divided into 2 groups. A total of 50 normal pregnant women (control group) in 2nd trimester (10-14 weeks of gestation) were compared with equal number of pregnant women with anaemia (study group) in 2nd trimester, aged between 20-30 years. Electrocardiogram was recorded using Philips twelve channel ECG machine model TC20 in both control and study groups to evaluate myocardial performance.

Haematological parameters were analysed by SYSMEX auto analyser. Analysis of Variance (One way ANOVA) was used for comparison between study and control groups and the data was analysed by t-tests.

Results: In our study a significant decrease in QRS duration and increase in QTc were observed in study group ($p<0.05$). T-wave abnormalities like flat and negative T-waves in lead II, III, avF, V2 – V4 were more frequent ($p<0.05$). 90% of subjects in study group had tachycardia and ECG abnormalities. There was a negative correlation between Hb level, serum ferritin and tachycardia, ECG abnormalities.

Conclusion: Pregnancy with Iron deficiency anaemia brings about various changes in ECG, suggesting that anaemia and volume overload in pregnancy is a risk factor that may lead to cardiac hypertrophy.

Keywords: Electrocardiogram, Serum ferritin, Tachycardia.

INTRODUCTION

Globally, anaemia is the most common disease and in developing country like India, iron deficiency anaemia predominates. Although, the prevalence of anaemia in countries with high development is estimated at 9%, in countries with low development the prevalence is 43% [1]. Anaemia affects various organs in body including the heart. True congestive heart failure rarely results from the anaemic state [2]. Similarly, maternal heart disease is the most important non-obstetric cause of death in pregnant women [3].

Pregnancy usually causes dramatic reversible changes in a woman's cardiovascular system. These remarkable changes begin soon after fertilization and continue throughout gestation to maintain healthy environment for the fetus and mother. The first haemodynamic change during pregnancy seems to be a rise in the heart rate [4]. In anaemia, the oxygen carrying capacity of blood decreases. The following mechanisms operate in anaemia to maintain a normal or near normal oxygen supply to the tissues [2]. Haemodynamic mechanism includes increased cardiac output; blood flow and its distribution; the oxygen-carrying capacity of the blood, i.e., haemoglobin concentration; and oxygen extraction. Among all these, the iron requirement also increases during pregnancy for fetal blood formation and iron is required for mothers own blood and cell mass. The degree of iron requirement depends on iron stores and the amount of dietary iron that can be absorbed during pregnancy. Iron depletion and the amount of stored iron are reduced in iron deficiency anaemia which limits the red cell production [5]. Stored iron can be estimated by serum ferritin in iron deficiency anaemia [6].

One of the important and simplest tools for the diagnosis of heart diseases is recording electrocardiogram. Electrocardiography is used to detect ischemic heart diseases, hypertensive heart diseases and asymptomatic arrhythmias [7].

Earlier studies have reported diverse changes on reports of ECG in anaemia [8,9]. Few studies have shown a decrease in QRS amplitude, T wave flattening and minor degrees of atrioventricular (AV) conduction disturbances [10], but these have not been observed in more recent studies [8]. Later studies have reported frequent non-specific ST-T wave changes [11]. However, the studies which show the effect of iron deficiency anaemia on myocardial function during pregnancy are few in India.

Hence, the present study is taken up to know the effect of iron deficiency anaemia on electrocardiograms during second trimester of pregnancy and to compare the ECG changes with normal pregnant women in second trimester.

MATERIALS AND METHODS

The study was conducted at antenatal OPD, Departments of Physiology and Cardiology of Prathima Institute of Medical Sciences Hospital between Oct 2014 to July 2015. Hundred pregnant women were selected for this study and divided in to 2 groups. Group I included 50 normal pregnant women (control group) in 2nd trimester (10-14 weeks of gestation) with normal clinical cardiovascular history and normal physical findings. Group II included equal number of pregnant women with iron deficiency anaemia (Haemoglobin% is 7-9.9g%, serum ferritin <4.6ng/ml), in 2nd trimester, aged between 20-30 years. Selected pregnant women were informed about the course and aim of the study and signed consent was obtained.

The study protocol was approved by ethical committees of B.L.D.E.U Shri BM Patil Medical College, Bijapur, Karnataka, India (IEC/29/2012) and Prathima Institute of Medical Sciences (Ref number: IEC/PIMS/2013/001. Pre-determined exclusion criteria for the selection of the study population were pregnant women with diabetes, maternal cardiovascular disease and pre-eclampsia.

Complete physical and obstetric examination was performed after taking detailed history from the selected subjects at the time of recruitment. Gestation was confirmed by last menstrual period and ultrasound measurement of the fetal crown-rump-length in selected pregnant women. Study was conducted between 9.00AM to 12PM. Subjects were asked to lie down in supine posture comfortably for 15 min before recording ECG and then electrocardiogram was recorded using Philips ECG machine model TC20 in both control and study groups to evaluate myocardial performance. The instrument used to record electrocardiogram was the twelve channel electrocardiograph HEWLETT PACKARD page writer manufactured by Philips Electronics Ltd. Haematological parameters were analysed using SYSMEX auto analyser. Serum Ferritin was quantitatived by Chemiluminscence Microparticulate Immuno Assay (CMIA).

STATISTICAL ANALYSIS

Data was expressed as Mean±SD. Analysis of Variance (One-way ANOVA) was used for comparison between anaemic pregnant women and normal pregnant women. The data was analysed by t-test (MINITAB 14 SOFTWARE). p< 0.05, p< 0.01 was considered statistically significant, p< 0.001 was considered highly significant (HS) and p> 0.05 was considered as not Significant.

RESULTS

[Table/Fig-1] shows demographic characteristic of the study population. Age and Body Surface Area (BSA) were almost similar in the two groups. This observation was not statistically significant (p>0.05). SBP showed an increase in study group when compared to control group. This observation was not statistically significant between control and study groups (p>0.05). DBP showed a decrease in study group when compared to control group. This observation was not statistically significant between control and study groups (p>0.05). [Table/Fig-2] shows comparison of haemoglobin concentration, RBC count between control and study groups. Hb% showed a statisticaliy significant decrease in study group when compared to control group (p<0.001). RBC showed a statistically significant decrease in study group when compared to control group (p<0.1). Serum ferritin showed a statistically significant decrease in study group when compared to control group (p<0.01).

[Table/Fig-3] shows comparison of Mean±SD, significance and range of QRS duration, QT interval, QTc interval and QRS axis between control and study groups of 2nd trimester pregnant women.

Parameter	Group –I	Group-II	p-value
	Control (n=50)	Study (n=50)	
Maternal age (years)	23±2	22±3	0.17 (NS)
Gestational age at the time of echo (week)	20 ±2	21 ±2	0.65 (NS)
Weight (kg)	47.40±4.43	50.32±6.28	0.09 (NS)
Height (cm)	140.3±3.5	141.2±4.0	0.2 (NS)
Body surface area	27.33±0.14	29.35±0.16	0.5 (NS)
SBP (mmHg)	101.6±6.62	102.3± 5.19	0.06 (NS)
DBP (mmHg)	68.8± 7.25	64.6±7.48	0.09 (NS)

[Table/Fig-1]: The anthropometric data in second trimester pregnant women of control & study groups.
p>0.05: Not Significant (NS), *p: <0.05: Significant,** p: <0.01: Highly Significant, *** p: <0.001: Very Highly Significant.

Parameter	Group –I	Group-II	p-value
	Control (n=50)	Study (n=50)	
Hb%	11.57±1.19	8.49±0.75	0.000 (HS)
RBC (millions/cumm)	4.16±0.41	3.89±0.40	<0.1 (HS)
Serum ferritin	41.76±52.25	4.89±1.21	0.002 (HS)

[Table/Fig-2]: Comparison of haematological parameters between two groups.
p>0.05: Not Significant (NS), *p: <0.05: Significant,
** p: <0.01: Highly Significant, *** p: <0.001: Very Highly Significant.

Parameter	2nd trimester		2nd trimester	p-value
	Control Group I		Study Group II	
	Mean±SD	Range	Mean±SD	
QRS duration	83.04±8.79	80-100ms	76.52±10.76	0.02 (S)
QT interval	365.04±24.89	320-360ms	350.32±17.44	0.06 (NS)
QTc interval	431.44±23.75	350-420ms	449.46±17.33	0.003 (HS)
QRS axis (in degrees)	46.44±16.24	22-82	44.36±21.21	0.7 (NS)
T axis (in degrees)	19.84±20.	-33-54	21.40±18.20	0.78 (NS)

[Table/Fig-3]: Comparison of Mean±SD, significance & range of QRS duration, QT interval, QTc interval & QRS axis between control & study groups.
p>0.05: Not Significant(NS), *p: <0.05: Significant,
** p: <0.01: Highly significant, *** p: <0.001: Very highly significant.

QRSD in sec in control 2nd trimester pregnant women without anaemia and in study group 2nd trimester pregnant women with anaemia were 83.04±8.79 and 76.52±10.76, respectively. This observation showed a statistically significant decrease in study group when compared to control group (p<0.02).

QT interval was decreased in study group when compared to control group. This observation was not statistically significant between control and study groups (p<0.06).

QTc interval showed statistically significant increase in study group when compared to control group (p<0.01).

QRS axis showed decrease in study groups. This observation was statistically not significant (p>0.05).

T axis showed an increase in study group when compared to control group. There was no statistically significant decrease between control and study groups (p>0.05).

T-wave abnormalities

In this study, incidence of T-wave abnormalities like flat T-waves and negative or inverted T-waves in lead II, III, avF and also in chest leads V2-V4 were statistically more in study group when compared to control group. This observation was statistically significant at p>0.05.

Pregnant women with anaemia in 2nd trimester (study group) showed sinus tachycardia and was statistically significant p>0.01. There was negative correlation between Hb%, serum ferritin and tachycardia, ECG changes i.e. as the Hb and serum ferritin levels decrease, there was an increase in occurrence of tachycardia and ECG abnormalities.

DISCUSSION

Electrocardiography is one of basic tools in the investigation of cardiovascular diseases [12]. Serum ferritin can be used to estimate the amount of stored iron and is conventional test for the diagnosis of iron deficiency anaemia. The other iron status markers such as, serum trasferrin and serum iron are of less clinical value in the diagnosis of iron depletion as there sensitivities were too low and the false positive rates too high. Despite physiological variations due to haemodilution, the serum ferritin concentration is currently the most reliable non-invasive marker of iron status in pregnancy [6,13]. The electrocardiogram during normal pregnancy may show wide variation from the normal non pregnant women. These variations may be due to the changed spatial arrangement of the chest organs as well as changed electrical properties of the myocardium due to low serum ferritin and haemoglobin levels. ECG recordings show changes with anaemia in pregnancy. In the current study tachycardia was observed in anaemic pregnant women, it could be due to increase in heart rate which is due to physiological adjustments in circulation during anaemia. To compensate anaemia cardiac output increases in order to maintain adequate oxygen supply. Cardiac output increases due to increase in blood volume, preload, heart rate, stroke volume along with a decrease in after load [14] Similar reports were given by Roy SB et al., [15].

But according to Gv S et al., Lokhotia M et al., tachycardia observed in their study seems to be is due to low basal parasympathetic outflow [16,17].

In addition the other changes seen in our study were T wave flattening and inversion.

In present study T wave abnormalities in lead II, III, aVF may be due to disturbances in myocardium, but not due to necrosis of heart muscle, resulting from oxygen deficiency caused by diminution of oxygen carrying power of the blood and due to increased workload on heart due to temporary ischemia represented by T wave inversion which is supported by studies J Misra, Szekely P, Zamani M et al., [18-20].

But some studies showed that T flattening is due to enlargement of QRS complex [10].

According to Pereira AA [14] T wave flattening is due to decreased QRS amplitude and minor degrees of atrioventricular disturbances.

QRSD: In present study, QRSD showed statistically significant decrease in study group when compared to control group. Altered circulatory dynamics during pregnancy might have some effect on its duration. Similar reports were given by Lechmanova et al., [21].

QT interval: In current study there was no statistically significant decrease in QT interval when compared between the control and study groups.

QTc interval: QTc interval in ECG reflects the time taken for depolarization and repolarization in the ventricular myocardium. In our study an increase in QTc interval may be due to tachycardia and complex consequence with changes in regulatory mechanisms during pregnancy. Also, supported by Sunitha M et al., Ozmen N et al., Carruth JE et al., Oram S et al., BN Nandini et al., in their studies [22-26]. In current study, prolongation of QTc interval may be due to low serum ferritin because prolongation of QTc is predominately dependent on K+ rectifier current. It is possible that low levels of ferritin might affect the ferritin dependent K+ current, both the outward and the inward rectifier current and that it may affect the QTc interval which was supported by Aerssens J et al., [27,28].

QRS axis: It is a measure of overall direction of depolarization of the ventricles. In current study QRS axis showed no statistically significant decrease in control and study groups.

T axis: In present study there was no statistically significant increase in T axis when compared between the control and study groups.

LIMITATIONS

In this study follow up was not possible because the study participants were from small cities and rural areas with limited medical facilities. Present study is cross-sectional study with ECG changes, however longitudinal study is required with more sample size and in different areas.

CONCLUSION

Pregnancy with iron deficiency anaemia brings about various changes like QRS duration QTc interval, ST depression wave changes and tachycardia in ECG. There was a negative correlation between Hb level, serum ferritin and ECG abnormalities. If anaemia persists for longer time it may lead to cardiac hypertrophy. Although, ECG recovery can be achieved with anaemia correction. This study clinically helps the condition of the heart for early diagnosis.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Nov 10, 2015**
Date of Peer Review: **Dec 19, 2015**
Date of Acceptance: **Feb 19, 2016**
Date of Publishing: **Mar 01, 2016**