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Original Research Article

Electrocardiographic pattern in hypertensive disorders of pregnancy

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ABSTRACT

Background: Hypertensive disorders of pregnancy are a major cause of poor pregnancy outcome and complicate ~6-11% of all pregnancies. When diagnosed during pregnancy, hypertension disorders escalate the maternal risk of placental abruption, cerebrovascular accident and disseminated intravascular coagulation, as well as fetal risk of intrauterine growth restriction, intrauterine death and prematurity. Interpretation of the ECG is an important component in the assessment of cardiovascular adaptations during pregnancy.
Methods: In this study, 105 pregnant women (gestational age >20 weeks) with hypertensive disorders of pregnancy (HDP) in the range of 18 to 45 years of age were recruited and compared with the equal number of age matched normotensive pregnant women. ECG parameters were compared with those of normotensive pregnant women.
Results: There was left axis deviation in 28.6% in HDP group as compared to 10.5% in control group, while as 71.4% and 84.8% had normal axis in HDP and control group respectively, 4.85% in control group had right axis deviation there was statistical significant difference between the two ($p<0.05$). There was statistically significant difference between the two groups in ECG characteristics of T wave flattening or inversion in lead III, T wave in lead V1, V2 and V3, ($p<0.05$). The mean QTc interval was found to be 440.28±43.62 msec in HDP women and 417.42±21.74 msec in normotensive control pregnant women and there was statistically significant difference between the two groups ($p=0.000$).
Conclusions: ECG abnormalities seen in patients with hypertensive disorders of pregnancy (HDP) include left axis deviation, T wave abnormalities, an alteration of ventricular repolarization as evidenced by prolongation of ECG parameters, such as QTc.

Keywords: Electrocardiography, Hypertension, Ventricular repolarisation

INTRODUCTION

Hypertensive disorders of pregnancy (HDP), such as pre-eclampsia (PE) and gestational hypertension, are associated with significant changes in maternal cardiac structure and function during pregnancy and are recognized as important risk factors for cardiovascular disease.[1] They are major cause of poor pregnancy outcome and complicate about 6–11% of all pregnancies.[2] Hypertensive pregnancies have increased risks of fetal growth restriction, placental abruption, preterm birth, cesarean delivery, and preeclampsia, which is a dangerous complication accompanied by proteinuria and may result in serious adverse consequences for the mother and fetus.[3-5] Traditionally, hypertensive disorders during pregnancy are classified into four categories:

(a) chronic hypertension, (b) preeclampsia-eclampsia, (c) preeclampsia superimposed on chronic hypertension and (d) gestational hypertension.[2]

Electrocardiographic (ECG) alterations in normal pregnancy, such as an increasing heart rate, reduction in PR interval, prolonged corrected QT interval (OTc), inverted or flattened T-waves, and leftward deviation of the QRS and T axes, have been reported in many previous studies.[6-7] However, only a few studies have evaluated the changes in ECG in hypertensive disorders of pregnancy.[8] Although the physiological changes in the ECG during pregnancy have been documented, the pattern of ECG in hypertensive disorders of pregnancy has not yet adequately been studied. This has stimulated the need of this crucial study to be undertaken. The aim of this study was to establish if standard ECG parameters could give additional information about the acute cardiac effects of hypertensive disorders of pregnancy even in the absence of symptoms.

METHODS

The study was performed on 210 patients admitted to the Department of Obstetrics and Gynecology of GMC Srinagar at LD hospital. It was performed from July 2018 to 31 January 2020 after institutional ethics committee clearance.

Inclusion criteria

Inclusion criteria for the study group (n=105) were the following: a diagnosis of gestational hypertension, pre-eclampsia, HELLP (hemolysis, elevated liver enzymes, low platelets) included.

Exclusion criteria

Those with known cardiovascular disease, systemic illnesses, and those requiring ICU admission due to any reason were excluded from the study. A total of 105 pregnant women without cardiovascular disease or gestational hypertension who attended the hospital were considered for the control group; twin pregnancies were excluded.

The two groups were comparable with regard to the same ECG parameters: Heart rate (min), QRS complex duration (ms), RR interval (ms), QT interval (ms), and corrected QT interval (ms) according to Bazzet's formula were calculated.

ECG

A standard 12-lead ECG was performed on all patients. Each ECG was analysed for common pathologic findings such as the following: ST changes (ST segment depression or elevation, flattening of the T wave, biphasic T waves or T-wave inversion), arrhythmias and other heart rate alterations, left ventricular hypertrophy, cardiac axis deviation. ECG parameters was compared between the women with hypertensive disorders of pregnancy (HDP) and the control group.

Statistical analysis

Descriptive statistics were expressed as numbers (n) and percent (%) for categorical variables and as the mean ±standard deviation for numerical variables. Differences between continuous and categorical variables among the groups were assessed using the independent Student's t-test and chi-square test. An overall 5% type-I error level was used to infer statistical significance and a p-value less than 0.05 was considered significant. Statistical analysis was performed using SPSS (Statistical Package for the Social Sciences) version 22.0 software (SPSS, Chicago, IL, USA).

RESULTS

The present study included 105 pregnant women with hypertensive disorders of pregnancy (HDP) (mean age, 28.93±4.06) and 105 healthy pregnant subjects (mean age, 29.31±2.98 years old). The baseline demographic and clinical, characteristics of the preeclampsia and control groups are summarized in Table 1. When we compared the baseline demographic and clinical characteristics in the two groups 89.60% (n=94) were from rural areas in HDP group as compared to 76.2% (n=80) in control group. 81% patients in HDP group and 62% in control group were multiparous. However, the mean and SD of gestational age at the time of study was 33.49±3.64 in case of HDP and 35.01±3.31 in case of control group.

Table 1: Baseline demographic and clinical characteristics of hypertensive disorders of pregnancy (HDP) and control group.

	HDP	Control
Residence		
Rural (N, %)	94 (89.60)	80 (76.2)
Urban (N, %)	11 (10.4)	25(23.8)
Age (years) (mean±SD)	28.93±4.06	29.31±2.98
Gestational age (weeks) (mean±SD)	33.49±3.64	35.01±3.31
Parity		
Primi (N, %)	20 (19)	40 (38)
Multiparous (N, %)	85 (81)	65 (62)

The ECG parameters of rhythm, axis, T wave in lead III, V1, V2 and V3 were compared between the HDP and control groups using chi-square test (Table 2). The QTc intervals of the two groups were compared using independent sample t test (Table 3, 4).

When the ECG parameters were evaluated between the HDP and control groups 34.3% women in HDP group had sinus tachycardia as compared to 29.5% in control

group while as about 63% in both the groups had normal sinus rhythm. There was left axis deviation in 28.6% in HDP group as compared to 10.5% in control group, while as 71.4% and 84.8% had normal axis in HDP and control group respectively, 4.85% in control group had right axis deviation there was statistical significant difference between the two ($p<0.05$). There was T wave flattening or inversion in lead III in 68.6% (n=72) in case of HDP group while 52.4% (n=55) in case of control group and there was statistical significant difference between the two groups ($p=0.001$). Similarly T wave in lead V1 was flat or inverse in 83.8% patients in case of HDP group while as it was in 83% pregnant women in control group and the difference was statistically significant ($p<0.05$). There was T wave inversion or flattening in leads V2 and V3 in HDP and control group and there was statistically significant difference ($p<0.05$). Q wave was present in 77.1% in lead III in case of HDP group while as it was present in 67.6% in control group.

Table 2: Comparison of ECG parameters between HDP and control groups.

		HDP (%)	Control (%)	P value
Rhythm	Normal sinus rhythm	66 (62.9)	67 (63.8)	0.371
	Sinus Bradycardia	3 (2.9)	7 (6.7)	
	Sinus tachycardia	36 (34.3)	31 (29.5)	
Axis	Left axis deviation	30 (28.6)	11 (10.5)	0.001*
	Normal axis	75 (71.4)	89 (84.8)	
	Right axis deviation	0 (0)	5 (4.8)	
T wave in III	Flat	44 (41.9)	25 (23.8)	0.012*
	Inversion	28 (26.7)	30 (28.6)	
	Upright	33 (31.4)	50 (47.6)	
T wave in V1	Flat	13 (12.4)	0 (0)	0.001*
	Inversion	75 (71.4)	83 (79.0)	
	Upright	17 (16.2)	22 (21.0)	
T wave in V2V3	Flat	2 (1.9)	0 (0.0)	0.003*
	Inversion	25 (23.8)	9 (8.6)	
	Upright	78 (74.3)	96 (91.4)	
Q wave in III	Present	81 (77.1)	71 (67.6)	0.123
	Absent	24 (22.9)	34 (32.4)	

Table 3: Mean and standard deviation (SD) of QTc of HDP and control group.

Group statistics					
		N	Mean	Std. deviation	Std. error mean
QTc	HDP	105	440.28	43.620	4.257
	Control	105	417.42	21.741	2.122

Table 4: Independent sample test comparing QTc of HDP and control group.

Independent samples test										
		Levene's test for equality of variances		t-test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
QTc	Equal variances assumed	30.638	0.000	4.806	208	0.000*	22.857	4.756	13.480	32.234
	Equal variances not assumed			4.806	152.667	0.000	22.857	4.756	13.460	32.254

The mean QTc interval was found to be 440.28±43.62 msec in HDP women and 417.42±21.74 msec in normotensive control pregnant women as shown in Table 3 and there was statistically significant difference between the two groups by using independent sample t-test ($p=0.000$) (Table 4 and Figure 1).

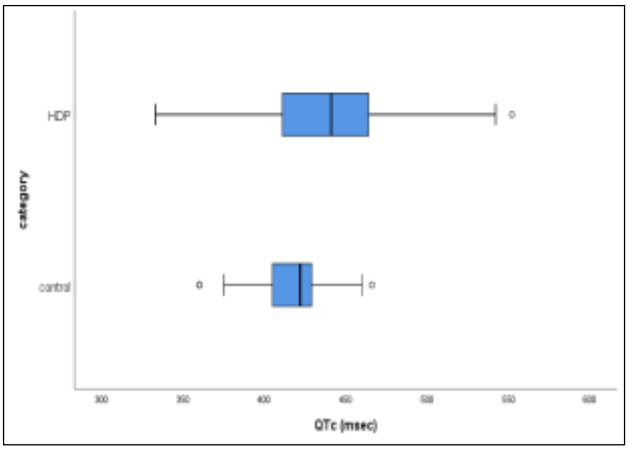

Figure 1: Boxplot for comparison of QTc interval of HDP and control group.

DISCUSSION

Hypertension disorders of pregnancy (HDP) complicate approximately 6-11% of all pregnancies and remain important causes of maternal and perinatal morbidity and mortality, particularly when high blood pressure (BP) is due to preeclampsia, either alone or superimposed on chronic vascular disease.[1,9] Approximately 1% of pregnancies are complicated by pre-existing hypertension, 5-6% by gestational hypertension, and 1-2% by preeclampsia.[10] The major hemodynamic changes induced by pregnancy include an increase in cardiac output, sodium and water retention leading to blood volume expansion, and decrease in systemic vascular resistance and systemic BP.[11,12] Typically, ECG alterations detected during normal pregnancy comprise sinus tachycardia, ectopic beats, left axis deviation, inverted or flattened T waves, a Q wave in lead III and the increased voltage unipolar left foot lead.[13]

Among the HDP group, 36 (34.3%) subjects had sinus tachycardia as compared to 31 (29.5%) in control group. There was left axis deviation in 30 (28.6%) patients with HDP as compared to 11 (10.5%) patients in control group. Similarly there were T wave changes in lead III, V1, V2 and V3 and q wave in lead III (Table 2). Isezuo and Ekele showed that eclampsia was associated with prolonged ventricular repolarization.[14] Compared to controls, the eclamptics had higher frequency of sinus tachycardia (9.0% vs. 13.3%). Revathi et al found that there were minor ECG changes like axis deviation, T-wave inversion in lead V2, lead III and increase in QTc interval were more frequently present in healthy pregnant compared to that of non-pregnant subjects.[15] Zangeneh et al compared left ventricular mass in pre-eclamptic group and normal pregnant women and observed that pre-eclamptic group had more left ventricular mass but difference were not significant.[16] ECG-derived diagnostic characteristics for LVH detection include among other features a leftward shift of electrical axis of the QRS in frontal plane.[17]

Melchiorre et al observed that more often diastolic dysfunction and increased cardiac load and left ventricular mass indices in pre-eclampsia suggesting that left ventricular remodeling was an adaptive reaction to maintain myocardial contractility with pre-eclampsia at term.[18]

In our study differences in T wave inversions in right precordial leads when compared between HDP and control group was statistically significant. Although T-wave inversions in V_1 to V_3 is a benign finding in the middle-aged population, inverted T waves in other leads carried >2-fold risk of cardiac and sudden arrhythmic death, and predicted hospitalization due to congestive heart failure or coronary artery disease.[19] It is well recognized that T-wave changes can be present in a variety of different circumstances affecting the heart and homeostasis of the body. These conditions include ischemia, ventricular hypertrophy, cardiomyopathies, myocarditis, certain drugs, electrolyte abnormalities, hyperventilation, and sympathetic simulation.[20,21]

In this study QTc significantly differed between the two groups. It is possible that HDP has a significant effect on ventricular repolarization. In a prospective study Isezuo et al observed women who developed eclampsia showed a significantly longer QTc interval.[14] In our study, QTc intervals of HDP women were more prolonged than those of the control group. The main consequence of a long QTc is the risk of arrhythmias, a risk that becomes real when QTc is >500 ms Raffaelli et al documented a longer mean QTc interval (442.7±26.7 vs. 423.7±20.7 ms; P0.001).[22,23]

Previous studies have shown that prolonged ventricular repolarization is a risk factor for ischemic heart disease and cardiovascular mortality in subjects with uncomplicated hypertension.[24] Among ECG parameters such QTc could be the earliest sign of asymptomatic ventricular electrical instability that could, in part, explain the increased future risk of cardiovascular disease in women with hypertension disorders of pregnancy.

The present study has some limitations that this study had a non-randomized design based around data from a single center with relatively small study population; therefore, the study may have been subject to selection bias.

CONCLUSION

Alteration of ventricular repolarization as evidenced by prolongation of ECG parameters QTc abnormalities in precordial leads may be induced in hypertensive disorders of pregnancy. Similarly T-wave changes present in hypertensive disorders of pregnancy can be seen in variety of different circumstances affecting the heart including ischemia, ventricular hypertrophy, and cardiomyopathies. These changes of electrocardiography are mostly asymptomatic, the simple, non-invasive assessment of ventricular repolarization on a standard 12-

lead ECG could be easily included in the clinical evaluation of women with hypertensive disorders of pregnancy. Further studies are needed, however, to demonstrate the relationship between abnormalities of ventricular repolarization and increased cardiovascular risk in these patients, so that the appropriate cut-off for risk stratification can be defined.

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