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Alterations in Heart Rate and Atria to Ventricular Conductivity in Third Trimester Pregnancy: A Comparative Study

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Abstract

The cardiovascular system undergoes physiological changes during pregnancy. These physiological changes in the heart can be understood by simple procedures like electrocardiography. With the objective of formulating basis of alterations in heart rate and impulse conductivity from atria to ventricles during pregnancy, the study was carried out in Manipal Teaching Hospital, Pokhara, Nepal between calendar year 2012 and 2013 by comparing electrocardiograms between pregnant and non-pregnant participants. The total number of participants in this study was 120: 50% was third trimester pregnant women as cases and the other 50% was non-pregnant women as controls. The statistically significant increase in heart rate and highly significant decrease in PR interval in electrocardiograms of cases conclude that the alterations in cardiac function do occur in pregnancies which all try to meet the growing demands of developing fetus. Thus, these changes neither should be misinterpreted as of pathological origin nor the latter one if present should be misdiagnosed by any health care providers.

Keywords

Electrocardiography, Heart, Pregnant, PR Interval

1. Introduction

The pregnancy-induced changes in the cardiovascular system develop primarily to meet the increased metabolic demands of the mother and fetus [1]. Knowledge of these changes is essential in the management of women with cardiovascular disease [2]. Though cardiovascular disease ranks as the prime indirect cause of maternal death as well as the most common cause of maternal death [3], little is known about the characteristics of the

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12-lead electrocardiogram (ECG) in pregnancy. There is evidence from various studies to suggest that some electrocardiographic parameters are, indeed, altered in the pregnant state [4]-[8]. According to the study conducted upon pregnant women, Katz *et al.* (1978) reported that the heart rate increased throughout pregnancy and reached to a peak in third trimester [9]. Similarly, this increase in heart rate was not purely linear but slightly curved according to Carla *et al.* [10]. Also, Suzanne *et al.* (1996) reported that the heart rate increased till thirtieth week of pregnancy and thereafter remained constant [11] [12]. An opposing finding was found in the study done by Desai *et al.* (2004) who reported most of the heart rate increase occurring in first, second and third trimesters; increase in heart rate wasn't significant [13]. Similarly, Ueland *et al.* (1969) found that the heart rate started rising by fifth weeks of gestation and continued only till thirty second week [14].

Many studies have also focused in changes in PR interval during pregnancy. Joseph *et al.* (1981) found that the mean PR interval was slightly shorter at third trimester when compared to second and first trimesters. However, clinically it wasn't recognized [5]. There was a statistically significant decrease in PR interval in all trimesters of pregnancy when compared to control group in a study comprising 50 women in each trimester of pregnancy and compared with another 50 age matched non-pregnant women as controls who had normal P-R interval in the study conducted by Nandini *et al.* in the year 2011. This increase in heart rate and the shortening of PR interval are attributed due to fast conduction of electrical impulses from atria to the ventricles. This increased conductivity leads to positive chromo tropic effect leading to increased cardiac output which eventually depends on heart rate and stroke volume. This shortening may thus aid to meet the increased demand of the growing fetus. However, some pathological conditions in which PR interval shortening occurs like Wolff Parkinson White syndrome, Lown Ganong Levine syndrome and various other pathological reasons of tachycardia may get confused if not diagnosed before pregnancy. Therefore, it is important not to diagnose heart disease when none exists and at the same time not to fail to detect and appropriately treat heart disease when it does exist during pregnancy [15].

2. Methods

In this prospective cross sectional study, sixty third trimester pregnant women and sixty non-pregnant women of same age group attending Manipal Teaching Hospital were included as per permission granted from ethical and research committee of the hospital. Subjects attending Emergency Department after labor pain and admitted in Gynecology and Obstetrics department were taken as cases. The cases with single gravid uterus who were primigravida were included by excluding women with multiple pregnancies, organic cardiac diseases, renal, endocrine or other metabolic disorders. The healthy non-pregnant female volunteers from the students, nurses and doctors were taken as control group. The subjects were taken as random sampling basis. The age group for the participants included between 20 to 35 years of age. The vitals of all participants were recorded. The 12 lead electrocardiograms of the participants were taken in resting supine position after informed consent. The heart rate and PR interval duration among pregnant and non-pregnant women were interpreted. The heart rate was calculated by counting number of small boxes between RR intervals divided by 1500. The data thus obtained were analyzed with the help of SPSS 16 version. The results were thereby compared between the cases and the controls. The mean values were compared with the help of independent T test with p value less than 0.05 as statistically significant and p value less than 0.001 as highly significant.

3. Results

The total numbers of participants were equally divided into cases and controls as shown in **Figure 1**.

Table 1 shows the age wise distribution of the participants in various intervals. The highest numbers of participants were in between 23 - 25 years of age.

Table 2 shows that the mean pulse rate was 81.93 ± 9.07 /min for third trimester pregnant women and 74.87 ± 6.73 /min in case of control group.

Table 3 shows the mean respiratory rate was 15.13 ± 1.33 /min in case of third trimester pregnant women and 15.57 ± 1.50 /min in case of control group.

Table 4 shows the mean systolic blood pressure was 114.30 ± 5.16 mmHg among third trimester pregnant women and 113.23 ± 5.77 mmHg for control group. Similarly, the mean diastolic blood pressure was 69.76 ± 8.05 mmHg in case of third trimester pregnant women and 66.76 ± 7.87 mmHg for control group.

Table 5 shows the comparisons of heart rate between two groups by electrocardiographic reporting. There

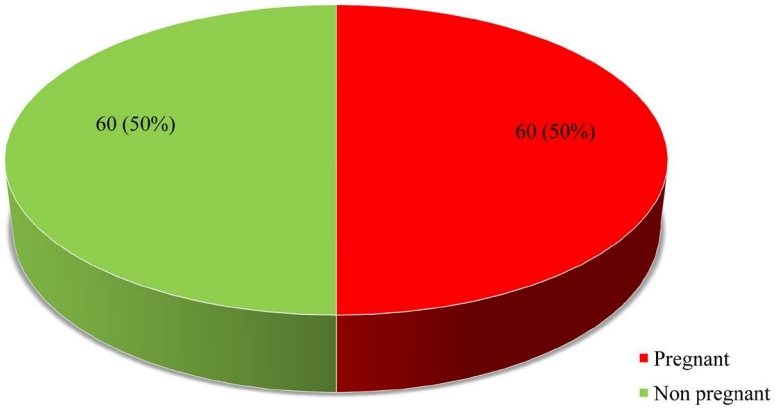

Figure 1. Percentage distribution of subjects in each group.

Table 1. Age wise distribution of participants in two groups (n = 120).

Age Groups (years)	Third Trimester	Control
20 - 22	18	28
23 - 25	23	28
26 - 28	7	4
29 - 31	9	0
32 - 34	3	0
>34	0	0
Total	60	60
Mean Age (yrs) ± SD	24.75 ± 3.51	22.80 ± 1.75

Table 2. Pulse rate in beats per minute observed between two groups.

Variables	Particulars	Third Trimester	Control
Pulse Rate (/min)	Mean ± SD	81.93 ± 9.07	74.87 ± 6.73
	Range	64 - 100	60 - 88

Table 3. Respiratory rate in cycles per minute observed between two groups.

Variables	Particulars	Third Trimester	Control
Respiratory Rate (/min)	Mean ± SD	15.13 ± 1.33	15.57 ± 1.50
	Range	12 - 17	12 - 18

Table 4. Blood pressure variations observed between two groups.

Variables	Particulars	Third Trimester	Control
SBP (mmHg)	Mean ± SD	114.30 ± 5.16	113.23 ± 5.77
	Range	110 - 126	90 - 124
DBP (mmHg)	Mean ± SD	69.76 ± 8.05	66.76 ± 7.87
	Range	60 - 88	60 - 82

SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

was statistically significant increase in heart rate in third trimester pregnant women when compared to control group with p = 0.002. The maximum number of non-pregnant women *i.e.* control group had heart rate between 71 - 80/min whereas for pregnant of third trimester it was between 81 - 90/min as shown in **Figure 2**.

Table 6 shows the comparison of mean PR intervals between two groups. There was statistically highly significant decrease in PR interval in third trimester pregnant women when compared to control groups with p = 0.00. The PR interval ranged from 0.12 - 0.18 seconds in control group and 0.08 - 0.16 seconds among third trimester pregnant women as shown in **Figure 3**.

Table 5. Comparison of heart rate (/min) between two groups.

Variables	Particulars	Third Trimester	Control	p Value
Heart Rate (/min)	Mean ± SD	82.08 ± 9.58	77.27 ± 6.45	0.002 (S)
	Range	65 - 104	64 - 90	

$p < 0.05$: S (Significant).

Table 6. Comparison of PR interval in seconds between two groups.

Variables	Particulars	Third Trimester	Control	p Value
PR Interval (sec)	Mean ± SD	0.12 ± 0.01	0.14 ± 0.01	0.00 (HS)
	Range	0.08 - 0.16	0.12 - 0.16	

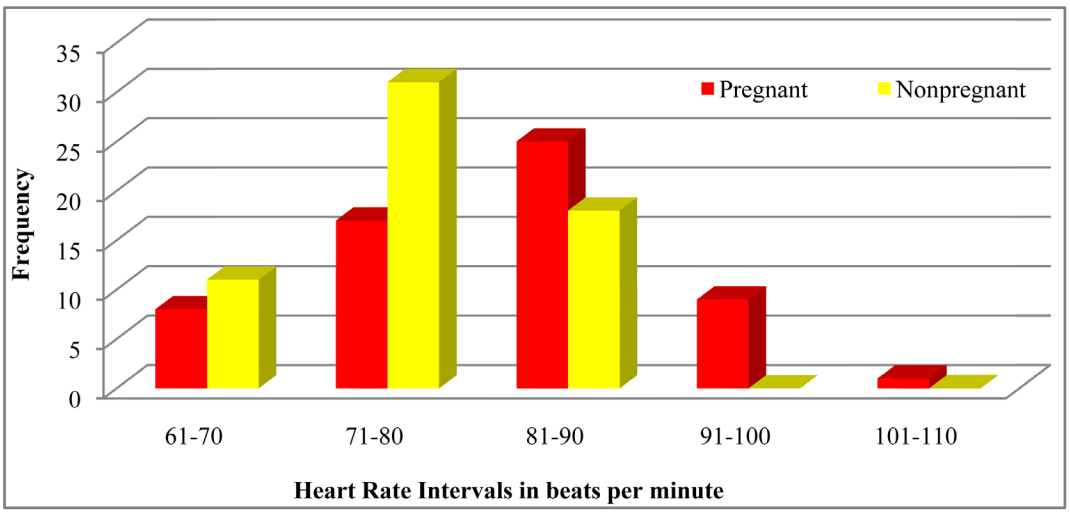

Figure 2. Heart rate distribution in two groups.

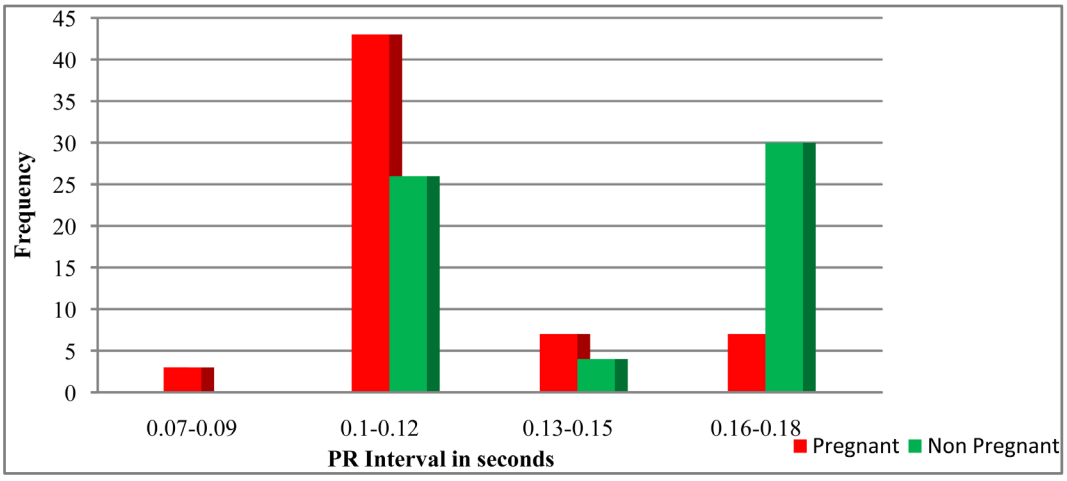

Figure 3. PR interval variation observed between two groups.

4. Discussion

The heart rate depends upon the auto-rhythmicity of Sino Atrial Node which is obviously under autonomic nervous system control. This study showed the statistically significant increase in heart rate of third trimester pregnant women when compared to non-pregnant group. This increase in heart rate during pregnancy is linked with autonomic nervous system changes that produce alteration in cardiac autonomic modulation. Failure of these adaptations may result in pregnancy related complications [16]. The increase in heart rate in early pregnancy is linked to hormonal mechanism. In relation to endocrinological factors in early pregnancy, the initial change in heart rate may be linked to the production of chorionic gonadotropin, with the later gradual increase being related to the vascular changes which accompany placental and fetal growth [17]. The increase in heart rate mainly during third trimester compensates for the fall in stroke volume resulting from caval compression [18]. Also the cardiac output increases as early as 5 weeks and rises to 45% above the baseline at 24 weeks of gestation. This is achieved by increase in heart rate and stroke volume [19]. However these changes couldn't be found in non-pregnant participants. The present study also showed that there was statistically highly significant decrease in PR interval in pregnant women when compared to normal controls. The decrease in PR interval could be due to shortening of A-V conductance with respect to increase heart rate accompanied during pregnancy. 43% of pregnant women had PR interval below the normal range in the study which showed the faster impulse conduction. This result is in parallel to that of Joseph *et al.* who found that the mean PR interval was shorter at third trimester pregnancy [5]. Similar decrease in PR interval in all trimesters of pregnancy when compared to control group was also reported by Nandini *et al.* [20]. However as no such physiological changes occurred in normal non-pregnant participants, the time taken for atria to ventricular conductivity wasn't as fast as it was in pregnant participants. This was showed by comparatively increase in PR interval in the controls as compared with the cases.

Similarly the mean pulse rate and mean systolic and diastolic blood pressure were increased during pregnancy. However, the mean respiratory rate was found to be comparatively decreased in pregnancy while compared to the non-pregnant state. The effect of progesterone and the increased abdominal pressure owing to pressure over the diaphragm may have decrease the respiratory rate in pregnancy.

5. Conclusion

The alterations in cardiac functions exist as physiological changes in pregnancy. The increase in such parameter has its own implication of supporting the growing fetus. The increase in heart rate and decrease in PR interval thus should not be treated as pathological ones. However, simple non-invasive procedures like electrocardiography before pregnancy will minimize the maternal risks of mismanagement in any disorders if present. Thus, whether electrocardiography has to be formulated as a routine examination before pregnancy is indeed an interesting question.

6. Limitation of the Study

The anxiety and fear in the participants especially the pregnant women could not be eliminated which may have altered the results. Further studies should also be carried out with individual matching of heights of participants from both groups.

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