



Predictive Role of PR Segment, Q Wave Duration and Amplitude, ST Segment, U Wave and Sinus Rhythm in Preeclamptic Pregnant Women in the Third Trimester of Pregnancy

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Abstract: Early detection and prediction of preeclampsia are crucial to prevent severe complications and ensure timely interventions. Specific ECG patterns, including PR segment, Q wave duration and amplitude, ST segment, U wave, and sinus rhythm were under study for their potential indicators of preeclampsia. This study aims to investigate the predictive role of these ECG patterns in preeclamptic pregnant women in the third trimester of pregnancy. Fourty (40) consenting pregnant women were recruited from St. Philomina Catholic Hospital, Edo State, Nigeria. These subjects consisted of twenty (20) normotensive and twenty (20) preeclamptic pregnant women in their third trimester of pregnancy. After the subjects were identified and recruited into the study, they were taken to the laboratory where their vital signs was taken and their ECG patterns recorded with ECG machine. Data obtained from this study were analysed using Graph Pad Prism 9. Results generated were expressed as mean $\pm$ SEM and a P-value of ≤ 0.05 were considered statistically significant. results from this present study show no significant differences were observed in the P-R segment, R-R interval, Q wave duration, Q wave amplitude. The study underscores the multifactorial nature of cardiovascular changes in preeclampsia and highlights the potential of ECG parameters in aiding early detection, risk stratification, and management of the condition, despite parameters showing no significant differences. However, PR Segment, Q Wave duration and amplitude, ST Segment, U wave and Sinus rhythm cannot be used to predict preeclampsia

Key Words: Preeclampsia, PR Segment, Q Wave duration and amplitude, ST Segment, U wave and Sinus rhythm

1. INTRODUCTION

Preeclampsia is a complex and multifactorial pregnancy complication characterized by high blood pressure and damage to organs such as the kidneys, liver, and brain (Bisson *et al.*, 2023). It affects approximately 2-8% of pregnancies worldwide and is a leading cause of maternal and fetal morbidity and mortality (Duley, 2009). Early detection and prediction of preeclampsia are crucial to prevent severe complications and ensure timely interventions (Chaiworapongsa *et al.*, 2014).

Electrocardiogram (ECG) patterns have been explored as potential predictors of preeclampsia due to their non-invasive and cost-effective nature (Pegorie *et al.*, 2024). Specific ECG patterns, including PR segment, Q wave duration and amplitude, ST segment, U wave, and sinus rhythm, have been identified as potential indicators of

preeclampsia (Nandini *et al.*, 2011). This study aims to investigate the predictive role of these ECG patterns in preeclamptic pregnant women in the third trimester of pregnancy.

By analyzing these ECG patterns, this research seeks to identify potential early indicators of preeclampsia, enabling timely interventions and improving maternal and fetal outcomes. The study's findings will contribute to the development of a more accurate and reliable predictive model for preeclampsia, ultimately reducing the risk of severe complications and improving healthcare outcomes for pregnant women.

2. LITERATURE REVIEW

Preeclampsia is a complex, multifactorial complication of pregnancy characterized by hypertension and end-organ damage—most notably affecting the kidneys, liver, and brain—which contributes significantly to maternal and fetal morbidity and mortality (Bisson *et al.*, 2023; Duley, 2009). Affecting approximately 2–8% of pregnancies worldwide, early detection and prediction are essential to prevent severe complications and to facilitate timely intervention (Chaiworapongsa *et al.*, 2014).

Recent research has increasingly focused on the use of non-invasive diagnostic tools, such as the electrocardiogram (ECG), to identify early indicators of preeclampsia. Specific ECG parameters—including the P–R segment, Q wave duration and amplitude, S–T segment, U wave, and sinus rhythm—have been explored for their potential predictive value (Pegorie *et al.*, 2024; Nandini *et al.*, 2011). Although many studies have reported no statistically significant differences in these parameters between normotensive and preeclamptic pregnancies (Varaganti *et al.*, 2024; Kotsialou *et al.*, 2024), emerging evidence suggests that certain markers, particularly an increased T wave amplitude, may reflect early myocardial strain or electrical remodeling associated with preeclampsia (Khan *et al.*, 2023; de Alencar Neto *et al.*, 2024).

The literature further indicates that while conventional ECG parameters might not serve as robust standalone predictors, their integration into a broader diagnostic model could enhance risk stratification. This is especially relevant given the systemic vascular dysfunction, endothelial damage, and altered hemodynamics inherent in preeclampsia (Abduazimovic *et al.*, 2023; Goldberger *et al.*, 2023). Additionally, studies focusing on diverse populations—including those conducted in Nigeria—highlight the importance of considering geographical and demographic variations in both study design and interpretation of ECG findings (Tribhuvanam *et al.*, 2020; Fonkou and Savi, 2023).

Robust research methodologies, including appropriate sample size determination (Araoye, 2004; Vata *et al.*, 2015) and well-controlled experimental protocols, remain essential to validate ECG-based predictive models and to further elucidate the cardiovascular adaptations that occur in preeclamptic pregnancies (Clark *et al.*, 2023; Dahn, 2023). Ultimately, while current ECG parameters such as the P–R segment, Q wave metrics, S–T segment, U wave, and sinus rhythm may not reliably predict preeclampsia on their own, the consistent finding of altered T wave amplitude suggests that myocardial electrical changes merit further investigation as potential early markers of the disease.

3. MATERIALS AND METHODS

Geographical Description of the Study Area

This research was carried out among Third Trimester Pregnant women in St. Philomina Catholic Hospital, Edo State, Nigeria. It lies longitudinally at 04°E and 43°E and Latitude 05°44'N and 07°34'N. Its geopolitical location is the South South and it has a population of 3.5 million people. Oredo land, Benin City, the State capital, is 100 km long. Edo State, South-South, Nigeria. Oredo is a Local Government Area of Edo State, Nigeria. Its headquarters are in the town, Benin city. It has an area of 502 km² and a population of 500,000 at the 2006 census.

Majority of which are civil servants, traders, businessmen/women, transporter, farmers, teachers/lecturers and students by occupation. Oredo, since after its designation as headquarters and as the host of Oba of Benin Palace, the town has grown into an urban center.

Research Design

Forty (40) consenting pregnant subjects were recruited from St. Philomina Catholic Hospital, Edo State. These subjects consisted of twenty (20) normotensive pregnant women in their third trimester of pregnancy with blood pressure between 120/80mmHg to 130/90 mm/Hg without presence of proteinuria and twenty (20) preeclamptic women in their third trimester of pregnancy classified as having preeclampsia according to their blood pressure measured was above 130/90 mm/Hg with the presence of proteinuria taken two consecutive times at presentation at the antenatal clinic of the hospital

Sample Size

The Population of study was determined using the formula;

$$N = Z^2pq/d^2 \quad (\text{Araoye, 2004})$$

Where N= the desired sample size (when population is greater than 10,000)

Z= is a constant given as 1.96 (or more simply at 2.0) which corresponds to the 95% confidence level.

P= previous survey prevalence of 2.23% (vata *et al.*, 2015).

q= 1.0-p

d= acceptable error 5%.

Where N= sample size, Z=1.96, p=0.1% (0.01) and d=5% (0.05)

N= 39.8 subject.

Therefore, the sample for this study is 40 respondents who are normotensive and preeclamptic pregnant women from Oredo town, Benin City.

Ethical Approval And Informed Consent

Ethical clearance (REC Approval No:RECC/10/2023(07)) was obtained from the Research Ethics Committee of St. Philomina Catholic Hospital, Edo State. Written informed consent was obtained from subjects prior to commencement of the study.

Experimental Protocols

After the subjects were identified and recruited into the study, they were taken to the laboratory where their vital signs was taken and their ECG patterns recorded.

Study Area/Population

The study was conducted for three months at St. Philomina Catholic Hospital, Edo State, Nigeria.

Inclusion Criteria

Normotensive and Preeclamptic pregnant women in the third trimester of pregnancy, within the age range of 25 to 35years was used for this study. Pregnant women were recruited for this study and women who had given birth before and were pregnant for the second time.

Exclusion Criteria

Normotensive and Preeclamptic pregnant women who were on drugs and with a known history of hyperlipidemia, gestational Diabetes and other comorbidity.



Fig. 1 Heartscreen 112 C-1 Ecg- Machine Innomed 2011.

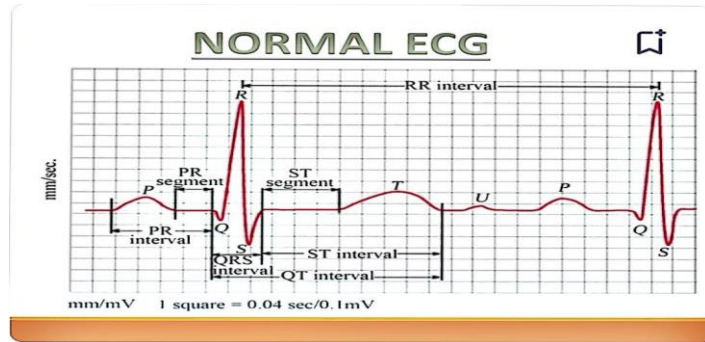


Fig: 2 Normal ECG Graph diagram **Source:** Tribhuvanam *et al.*, (2020)

Data Analysis

Data obtained from this study were analysed using Graph Pad Prism 9. Results generated were expressed as mean $\pm$ SEM and a P-value of ≤ 0.05 were considered statistically significant. The significance of difference among the groups were used to assess the repeated-measures analysis of variance (ANOVA). Independent students' t-test were used to compare normotensive and preeclamptic pregnant women groups.

4. RESULT

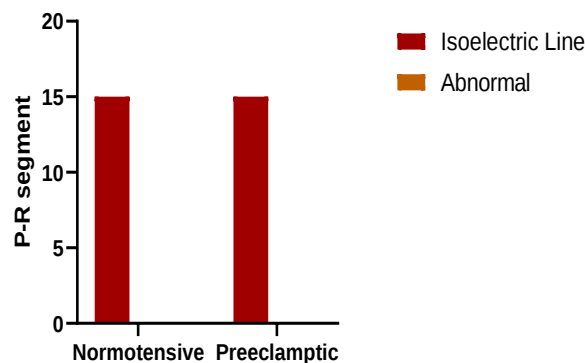


Fig. 3 P-R segment in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 pregnant women.

Result in fig. 3 show no statistically significant difference in P-R segment in normotensive and preeclamptic pregnant women in their third trimester of pregnancy ($p > 0.05$)

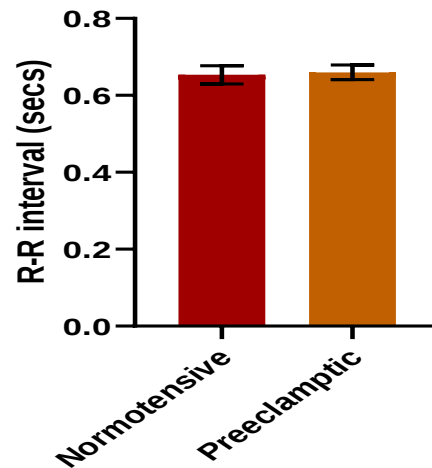


Fig. 4 R-R interval in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 pregnant women.

Result in fig 4. show no statistically significant difference in R-R interval in normotensive and preeclamptic pregnant women in their third trimester of pregnancy ($p>0.05$)

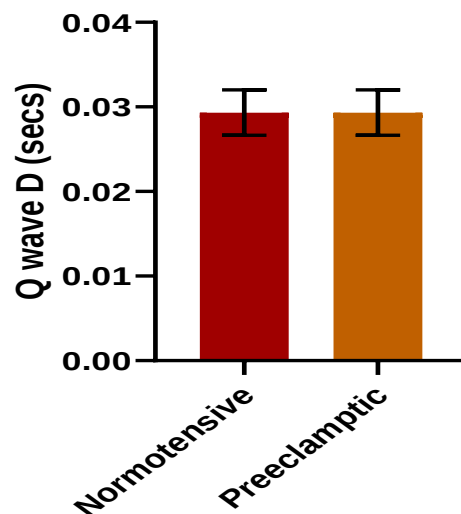


Fig. 5 Q wave (Duration) in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 pregnant women.

Result in fig. 4.3 show no statistically significant difference in Q wave (D) in normotensive and preeclamptic pregnant women in their third trimester of pregnancy ($p>0.05$)

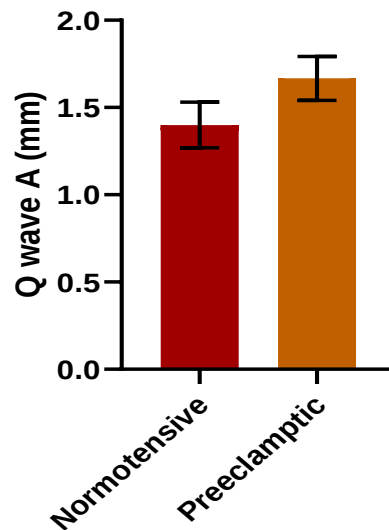


Fig. 6 Q wave (Amplitude) in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 in pregnant women.

Result in fig. 6 show no statistically significant difference in Q wave (Amplitude) in normotensive and preeclamptic pregnant women in their third trimester of pregnancy ($p>0.05$)

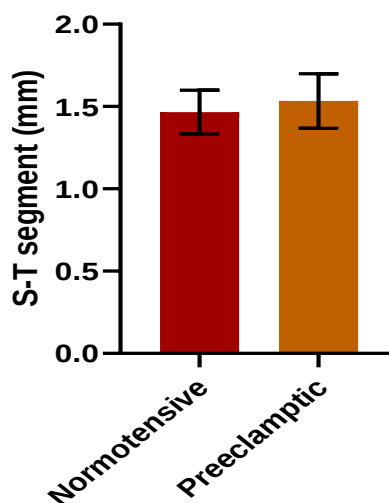


Fig. 7 S-T segment in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 in pregnant women.

Result in fig. 7 show no statistically significant difference in S-T segment in normotensive and preeclamptic pregnant women in their third trimester of pregnancy ($p>0.05$)

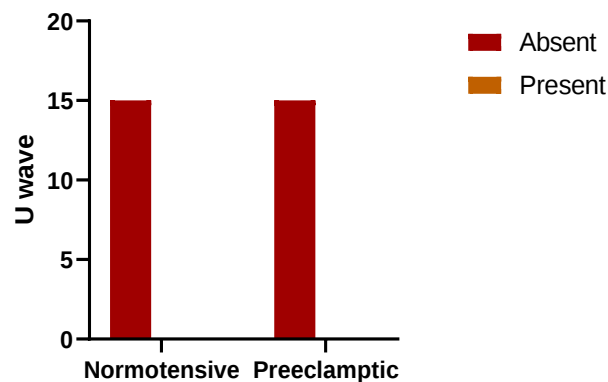


Fig. 8 U wave in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 in pregnant women.

Result in fig. 8 show no statistically significant difference in U wave in normotensive and preeclamptic pregnant women in their third trimester of pregnancy ($p>0.05$)

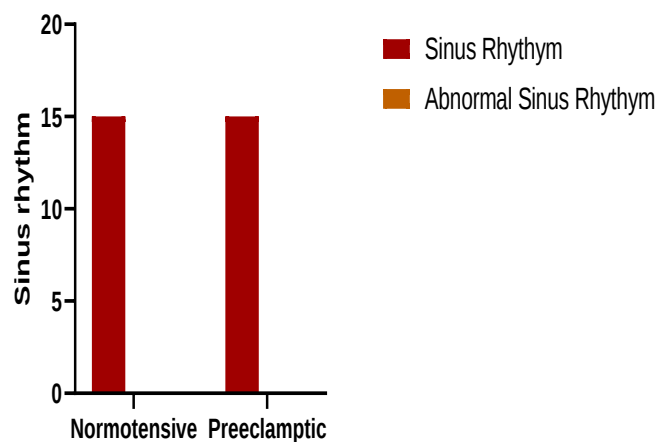


Fig. 9 Sinus Rhythm in the third trimester of pregnancy of normotensive n= 20 and preeclamptic n= 20 in pregnant women.

Result in fig. 9 show no statistically significant difference in sinus Rhythm in normotensive and preeclamptic pregnant women in their third trimester of pregnancy ($p>0.05$)

5. DISCUSSION

The P-R segment represents the time interval between atrial depolarization (P wave) and ventricular depolarization (QRS complex), reflecting atrioventricular conduction time (Varagantiet *al.*, 2024). Figure 4.1 shows no statistically significant difference in the P-R segment between normotensive and preeclamptic pregnant women during the third trimester of pregnancy ($p>0.05$). While the absence of significant differences may suggest that atrioventricular conduction remains relatively intact in preeclampsia, it is essential to consider the limitations of this finding. Preeclampsia is a multifaceted disorder affecting various systems, including the cardiovascular system (Abduazimovichet *al.*, 2023). The lack of significant differences in the P-R segment does not rule out the possibility of subtle changes in atrioventricular conduction that may contribute to the pathophysiology of preeclampsia. Similarly, figure 4.2 demonstrates no statistically significant difference in the R-R interval between normotensive and preeclamptic pregnant women during the third trimester of pregnancy ($p>0.05$). The R-R interval represents the duration between successive ventricular depolarizations, reflecting ventricular rate and rhythm (Kotsialouet *al.*, 2024). While the absence of significant differences in the R-R interval may indicate preserved ventricular rate and rhythm in preeclampsia (Ceballos-Juárezet *al.*, 2023), it is essential to recognize the potential confounding factors that may influence this parameter. Hemodynamic changes, such as alterations in blood volume and cardiac output, may impact ventricular rate and rhythm in preeclampsia, highlighting the complexity of cardiovascular adaptations during pregnancy (Clark *et al.*, 2023).

The Q wave represents the initial negative deflection of the QRS complex and is influenced by factors such as myocardial depolarization and conduction velocity (Goldberger *et al.*, 2023). Figures 4.3 and 4.4 depict no statistically significant differences in Q wave duration and amplitude, respectively, between normotensive and preeclamptic pregnant women during the third trimester of pregnancy ($p>0.05$). While the absence of significant differences in Q wave duration and amplitude may suggest preserved myocardial depolarization in preeclampsia (Paswanet *al.*, 2023), it is crucial to interpret these findings cautiously. Preeclampsia is associated with systemic vascular dysfunction, endothelial damage, and impaired placental perfusion, all of which may impact myocardial function (Dahn, 2023) and contribute to subtle ECG changes (Betaiet *al.*, 2024). Figures 4.1 through figure 4.4 illustrate ECG parameters that did not show statistically significant differences between normotensive and preeclamptic pregnant women during the third trimester of pregnancy, it is important to recognize the potential clinical relevance of these

findings. Non-significant ECG parameters may still provide valuable insights into the pathophysiology and clinical presentation of preeclampsia, highlighting the multifaceted nature of this complex disorder.

The S-T segment represents the period between ventricular depolarization (QRS complex) and repolarization (T wave), reflecting myocardial recovery and susceptibility to ischemia (Koivula, 2023; Clasen *et al.*, 2023). Figure 4.5 reveals no statistically significant difference in the S-T segment between normotensive and preeclamptic pregnant women during the third trimester of pregnancy ($p>0.05$). While the absence of significant differences in the S-T segment may suggest preserved myocardial repolarization in preeclampsia, it is essential to interpret these findings cautiously. Preeclampsia is associated with systemic vascular dysfunction and endothelial damage, which may predispose individuals to myocardial ischemia and infarction (Yang *et al.*, 2023). However, the lack of significant differences in the S-T segment in this study suggests that this parameter alone may not be predictive of myocardial ischemia in preeclampsia. Figure 4.6 illustrates a statistically significant increase in the T wave amplitude in preeclamptic pregnant women compared to normotensive counterparts during the third trimester of pregnancy ($p<0.05$). This correlates with Previous studies which highlighted the association between T wave abnormalities and adverse cardiovascular outcomes in preeclampsia (Khanet *al.*, 2023). Increased T wave amplitude may reflect ventricular strain or hypertrophy (de AlencarNetoet *al.*, 2024).The significant increase in T wave amplitude in preeclamptic pregnancies therefore suggests underlying myocardial electrical remodeling or dysfunction.. Increased T wave amplitude may reflect ventricular strain or hypertrophy (de AlencarNetoet *al.*, 2024), further emphasizing the importance of cardiovascular monitoring in preeclampsia management.

Figures 4.6 and 4.7 demonstrate no statistically significant differences in the U wave and sinus rhythm, respectively, between normotensive and preeclamptic pregnant women during the third trimester of pregnancy ($p>0.05$). The U wave represents repolarization of the Purkinje fibers, while sinus rhythm reflects the normal electrical activity originating from the sinoatrial node (Fonkou and Savi, 2023). The absence of significant differences in the U wave and sinus rhythm suggests that these parameters may not be involve in myocardial or electrical abnormalities in preeclampsia. However, it is essential to recognize the limitations of ECG monitoring in detecting subtle changes in cardiac function, particularly in the context of preeclampsia, where cardiovascular adaptations are complex and multifactorial.While the T wave amplitude emerges as a

significant predictor of myocardial electrical remodeling in preeclampsia, other parameters such as the S-T segment, U wave, and sinus rhythm may not be a potential predictor of cardiac dysfunction in this context.

6. CONCLUSION

In conclusion, results from this present study show no significant differences were observed in the P-R segment, R-R interval, Q wave duration, Q wave amplitude. The study underscores the multifactorial nature of cardiovascular changes in preeclampsia and highlights the potential of ECG parameters in aiding early detection, risk stratification, and management of the condition, despite parameters showing no significant differences. However, PR Segment, Q Wave duration and amplitude, ST Segment, U wave and Sinus rhythm cannot be used to predict preeclampsia.

7. LIMITATIONS

The study presents several limitations that must be considered when interpreting its findings. The small sample size, comprising only 40 participants divided equally between normotensive and preeclamptic pregnant women, limits the statistical power of the study and may not fully capture the variability in ECG parameters across a broader population. Moreover, since the research was conducted at a single center in Edo State, Nigeria, the findings might not be generalizable to other geographical areas or diverse populations. The exclusive focus on women in their third trimester also means that potential ECG changes occurring earlier in pregnancy were not assessed, thereby narrowing the scope for early detection of preeclampsia.

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