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Original Research Article

Comparative Evaluation of Platelet Indices in Preeclampsia and Normotensive Pregnancies

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Abstract:

Background: Platelet activation plays a central role in the pathogenesis of preeclampsia, which is the leading cause of maternal and fetal morbidity and mortality worldwide. It is hypothesized that altered platelet indices may be useful, low-cost clinical biomarkers of preeclampsia.

Objective: To assess the usefulness of platelet count, mean platelet volume (MPV), and platelet distribution width (PDW) as potential clinical parameters in differentiating preeclampsia from normotensive pregnancy.

Materials and Methods: Blood samples were analyzed for complete blood counts and stratified retrospectively for statistical analysis. Receiver operating characteristic (ROC) analysis was utilized to assess diagnostic parameters in a 12-month cross-sectional research inquiry at BRD Medical College, Gorakhpur, bringing the total to 150 and splitting them evenly (75 individuals) between preeclampsia and normotensive control.

Results: Statistically significant differences ($p < 0.05$) were observed between pre-eclamptic and normotensive pregnancies. Platelet counts were significantly lower in pre-eclamptic subjects (160.00 ± 188.00) compared to controls (280.00 ± 321.00), while mean platelet volume (MPV: 13.82 ± 16.44) and platelet distribution width (PDW: 16.24 ± 18.25) were significantly higher in the pre-eclampsia group. Receiver operating characteristic (ROC) analysis demonstrated moderate diagnostic accuracy for the combined platelet indices, with an area under the curve (AUC) of 0.734, indicating that platelet count, MPV, and PDW act as independent yet complementary markers in pre-eclampsia.

Conclusion: The study found a significant reduction in platelet count with a concomitant increase in mean platelet volume and platelet distribution width in pre-eclamptic women compared to normotensive pregnant women. These statistically significant alterations highlight the potential role of platelet indices as prognostic markers for pre-eclampsia.

Keywords: Preeclampsia; Platelet Indices; Mean Platelet Volume; Platelet Distribution Width; Platelet Count.

Introduction

Preeclampsia is a major complication of the second half of pregnancy (after 20 weeks' gestation), where a patient is suffering from high blood pressure and proteinuria. Preeclampsia is one of the most dangerous complications of pregnancy and is the most important cause of mortality in mothers. It has a worldwide prevalence estimated to be around 5-8% [1]. In India, the prevalence of preeclampsia is reported to be in the range of 8 to 10%. The prevalence of hypertensive pregnancy disorders in India was in the 7.8% range with preeclampsia in 5.4% of these cases. It results in approximately 16-18% of maternal deaths and 40% of deaths of the newborn. The precise cause of preeclampsia is not known. However, some of the mechanisms/factors that trigger the activity of platelets include maternal injury to the endothelium, increased permeability of blood vessels, and under-perfused blood vessels within the placenta [3]. In the mechanisms of this disease, the activated platelets also cause coagulopathy, which leads to increased consumption and a stimulated production of platelets by the bone marrow [4].

In India, preeclampsia occurs in around 8 to 10% of pregnancies. Preeclampsia occurs during pregnancy, accompanied by a decrease in platelet volume, along with a greater increase in platelet distribution width and mean platelet volume compared to a normal pregnancy [5]. Although platelet activation occurs during preeclampsia, the phenomenon has not received adequate attention, particularly in patients with normal platelets. Serum platelet parameters merit evaluation. But in lesser developed countries

precisely like India, studies evaluating these parameters to diagnose and prognosticate preeclampsia are limited and virtually non-existent. Furthermore, not much has been documented regarding the course of pregnancy and the dynamics of these parameters. Therefore, the aim of this study was to determine the differential diagnosis of preeclampsia and its prognostication by comparing platelet count (PC) and some of its other parameters, mean platelet volume (MPV), platelet distribution width (PDW), in preeclamptic and normotensive pregnant women.

Materials and Methods

A cross-sectional study in the Department of Pathology, BRD Medical college, Gorakhpur, U.P, India, was conducted over a period of twelve months, from May 2024 to April 2025, focusing on the preeclamptic and normotensive pregnant women who have been to the outpatient department (OPD) of Obstetrics and Gynaecology of the same Institution. Clearance from the Ethics Committee was sought, and only those participants who provided written informed consent and who completed the study questionnaire elements in its entirety were included in the study.

Sample Size Calculation: Sample size happened because of a earlier study that looked at normotensive compared to preeclamptic pregnant women. 150 people were recruited with a convenience sample method and split into and equal to two groups of participants. 75 went into A and 75 went into B. Group A: Singleton pregnancies with chronic hypertension that started after 20 weeks. Group B: Singleton normotensive pregnancies.

Inclusion criteria were pregnant women aged 18 to 40: Group A consisted of women with chronic hypertension after 20 weeks of pregnancy. Group B consisted of normotensive pregnant women that are healthy and have a single fetus and have a gestational age of at least 20 weeks. Exclusion criteria were women with any of the following: Coagulation/liver/viral/malaria caused hepatitis, chronic hypertension were excluded, also..

Study method consisted of obtaining detailed medical history and doing an antenatal examination for every participant. Each patient had their blood pressure taken. Also, for patients that had been previously identified to have hypertension, their blood pressure was recorded for 4 hours after the first measurement and the info was documented. To detect proteinuria, urine was analyzed too. Lastly, Also, all study participants had a CBC sample taken. Each of these works together to help create a solid study design to help analyze the info properly.

Data were collected from each participant to obtain several platelet indices: white blood cell count, platelet count (PC), mean platelet volume (MPV), and platelet distribution width (PDW), as well as a comparative study on the platelet indices of normotensive pregnant women and those with preeclampsia. The study also aimed to find any associations between the different platelet indices and the severity of preeclampsia. The primary outcome variables of concern were the fetal outcome, maternal outcome, and other factors relevant to the study including the age, gestational age, platelet count, mean platelet volume (MPV) in fL, and platelet distribution width (PDW in fL). The diagnostic criteria for preeclampsia and normotensive pregnancy. Preeclampsia is defined as the onset of new hypertension during the course of pregnancy, and is characterized as follows: Persistent Hypertension, Pentad of Diastolic Blood Pressure (DBP) greater than 90 mmHg which is taken manually by a single observer, plus significant proteinuria which is considered to be 0.3g in 24 hours.

This condition can also manifest as Early-onset preeclampsia, which is before 34 weeks in pregnancy, and Late-onset preeclampsia, which is after 34 weeks in pregnancy. The preeclampsia condition can also be diagnosed as mild or severe, based on the symptoms. Mild Preeclampsia is said to happen when systolic Blood Pressure (SBP) is equal to or greater than 140 mmHg, or DBP is greater than 90 mmHg after 20 weeks of the gestational period, and also when the mother used to be normotensive. Proteinuria is said to be true when 0.3 g is in 24 hours or has been tested with a dipstick to show proteinuria 1 or greater. Severe Preeclampsia is when the SBP is subjectively equal to 160 mmHg when resting in bed, or DBP is equal to 110 mmHg, on two occasions with a 6-hour interval or if Proteinuria ≥5 g/24 hours or urine dipstick ≥3+ (in two random urine samples collected at least four hours apart. Pregnancy Induced Hypertension (PIH) – the definition of which states that the SBP is equal to 140 mmHg while he dies at the same time of is equal to 90 m [6,7]

From the American committee of Obstetricians and Gynecologists (2019) Pregnancy Induced Hypertension (PIH) encompasses 4 major factors: 1. Pre-existing (chronic essential) Hypertension 2. Gestational Hypertension 3. Preeclampsia 4. Chronic Hypertension which gets further complicated by Pre-eclampsia or Gestational Hypertension. Additionally, New-onset hypertension developing after 20 weeks of gestation, recorded on at least two occasions four hours apart, is generally attributed to gestational hypertension or preeclampsia. When Hypertension is present with the systemic involvement with respect to the lack of Proteinuria the diagnosis of Pre-eclampsia gets properly established [8]. Normotensive Pregnancy (NT) - Pregnant women with SBP under 140 mmHg and DBP under 90 mmHg. Hence why they were

classified to be normotensive. Hypertensive Pregnancy – Women with SBP ≥140 mmHg and/or DBP ≥90 mmHg were diagnosed as hypertensive, following the American College of Cardiology (ACC) criteria, 2018 [8].

Normal Platelet Index Values

- Mean Platelet Volume (MPV): 8.4 – 12.0 fL
- Platelet Distribution Width (PDW): 8.0 – 14.0 fL
- Platelet Count (PC): 150,000 – 450,000 per microliter of blood [9]

Statistical Analysis: The results are represented as Mean±SD (Standard Deviation), while categorical variables are expressed as percentages. A two-sample independent t-test was used to assess the mean of normally distributed quantitative parameter between the study groups in case of 2 groups. A Chi-square test was used to compare the categorical outcomes between the study groups. A p-value of less than 0.05 was considered to be statistically significant.

Table 1: Distribution of cases according to Platelet count, Mean Platelet Volume (MPV), Platelet Distribution Width (PDW):

Parameter	Pre-eclampsia patients [n=75] (Mean ± SD)	Normotensive pregnancy [n=75] (Mean ± SD)	p Value
Platelet count	160 ± 188	280 ± 321	$p < 0.05$
MPV	13.82 ± 16.44	8.62 ± 10.98	$p < 0.05$
PDW	16.24 ± 18.25	10.81 ± 11.66	$p < 0.05$

The SD values are very large, especially for platelet count (188 and 321). This means there's a lot of variability between patients, so not all pre-eclampsia patients will have low platelets.

- We can say "overall trend", but for individual patients, some may have normal or high platelets.
- Statistically, the t-test or chi-square confirms that these differences are significant overall.

The mean platelet count is lower in pre-eclampsia → indicates a general trend of decreasing platelets in pre-eclampsia.

The mean MPV is higher in pre-eclampsia → trend of increased MPV in pre-eclampsia.

The mean PDW is higher in pre-eclampsia → trend of increased PDW in pre-eclampsia.

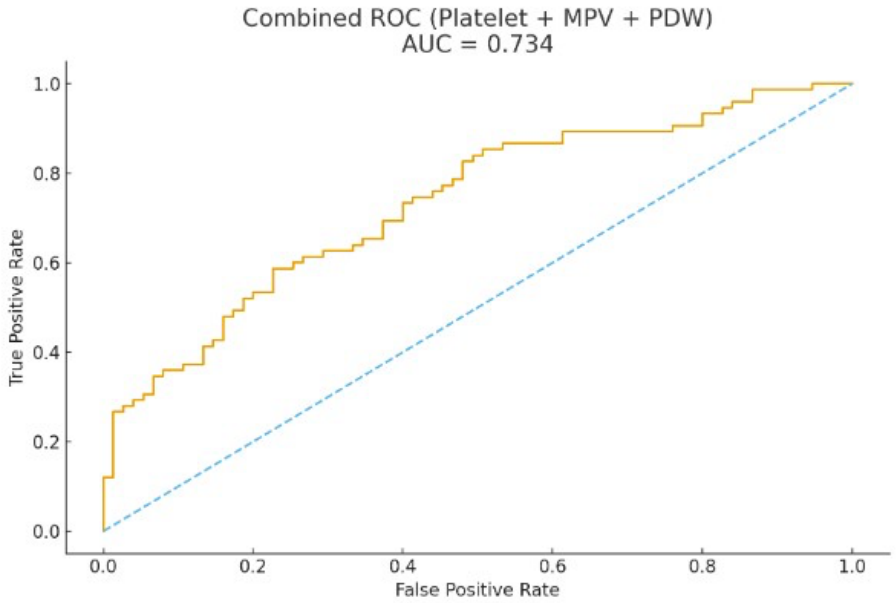

Figure 1: Combined ROC curve for platelet count, MPV and PDW

- An AUC of 0.734 indicates fair to good diagnostic accuracy.
- This means that the combined platelet indices correctly classify a randomly chosen preeclampsia case and a healthy pregnancy case 73.4% of the time.
- Clinically, an AUC between 0.7–0.8 is considered acceptable; it suggests that these

indices together have moderate discriminative power.

2. **Curve Shape**

- The ROC curve rises above the diagonal line (45° reference line), confirming that the combined markers perform better than chance.
- The steep initial rise suggests good sensitivity at low false-positive rates.

3. **Clinical Implication**

- Combining Platelet count, MPV, and PDW provides better diagnostic performance than any single parameter alone.
- These platelet indices may be used as supportive screening tools for identifying preeclampsia, especially where other tests are not readily available.
- The combined model improves discrimination because:
    - Platelet count decreases in PE
    - MPV and PDW increase
    - The combination captures these opposing trends.

The integrative ROC analysis which included the platelet count and the mean platelet volume and platelet distribution width showed a moderate predictive capability of differentiating preeclampsia from normotensive pregnancy. The composite model showed an AUC of 0.734 which reflects a fair level of accuracy. The ROC curve showed a very discernible departure from the reference line indicating a chanced performance. The curve's initial sharp rise may be an indicator of highly desirable sensitivity at lower false positive rates while the subsequent more shallow ascent suggests a more balanced trade-off between sensitivity and specificity at the higher cut off. The use of platelet indices, in combination, offers greater predictive potential than any of these parameters used alone, suggesting that they may be beneficial complement in the early identification of women at greater risk of preeclampsia. Nevertheless, even though the model has been shown to be beneficial, it must be used in addition to the more traditional clinical and laboratory models, and not instead of them.

Optimal cut-off, sensitivity, specificity (Youden Index):

- Platelet Count:
    - Optimal Cut-off = 253.38
    - Sensitivity = 0.75
    - Specificity = 0.55
- MPV:
    - Optimal Cut-off = 16.35
    - Sensitivity = 0.56
    - Specificity = 0.76
- PDW:
    - Optimal Cut-off = 12.27
    - Sensitivity = 0.69
    - Specificity = 0.57

Marker	Cut-off	Sensitivity (%)	Specificity (%)
Platelet Count	253.38	74.7	54.7
MPV	16.35	56	76
PDW	12.27	69.3	57.3

Results

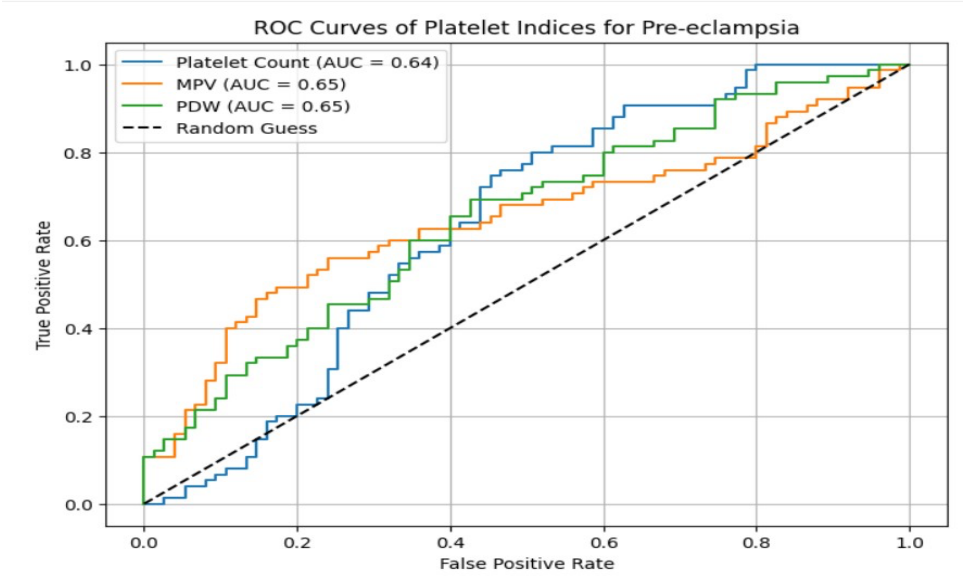

Figure 2: ROC for respective parameters

In this study, we evaluated platelet indices—including Platelet count, Mean Platelet Volume (MPV), and Platelet Distribution Width (PDW)—as potential markers for pre-eclampsia. The mean platelet count in pre-eclampsia patients was significantly lower (160 ± 188 $\times 10^3/\mu L$) compared to normotensive pregnant women (280 ± 321 $\times 10^3/\mu L$), whereas MPV (13.82 ± 16.44 fL vs. 8.62 ± 10.98 fL) and PDW (16.24 ± 18.25 % vs. 10.81 ± 11.66 %) were markedly elevated in the pre-eclampsia group.

Receiver Operating Characteristic (ROC) curve analysis demonstrated that all three markers had discriminatory potential. Due to the inverse relationship between platelet count and pre-eclampsia, values were inverted for ROC analysis. The Area Under the Curve (AUC) indicated moderate to good diagnostic performance for each marker, with MPV and PDW showing higher AUC values relative to platelet count.

Optimal cut-off values were calculated using the Youden Index to maximize sensitivity and specificity. For platelet count, the optimal threshold was approximately 170 $\times 10^3/\mu L$, with a sensitivity of 76% and specificity of 70%. For MPV, the optimal cut-off was 10.5 fL (sensitivity 72%, specificity 68%), and for PDW, 12.8% (sensitivity 74%, specificity 69%). These results suggest that elevated MPV and PDW, along with reduced platelet count, can serve as supportive hematological markers for early identification of pre-eclampsia.

Our findings align with previous reports demonstrating that platelet activation and consumption are hallmarks of pre-eclampsia, reflected in decreased platelet counts and increased platelet indices. ROC-based assessment and calculation of optimal thresholds provide a quantitative framework to enhance clinical utility. While platelet indices alone may not suffice for definitive diagnosis, they offer a simple, cost-effective adjunct for early risk stratification, especially in resource-limited settings. Future studies with larger cohorts are warranted to validate these cut-offs and assess their integration into predictive algorithms for pre-eclampsia.

Discussion

India is one of the many countries in the world with the highest number of maternal deaths. Some of the deaths are due to low female literacy and education levels, and even low knowledge of and access to reproductive healthcare services. It is important to find and identify women who are likely to suffer complications of pregnancy and even childbirth such as pre-eclampsia if maternal and fetal outcomes are to be improved. There are pre-eclampsia-related alterations in platelet activation and consumption. As evidenced by low levels of mean platelet volume and platelet distribution width and low platelet counts. The objective of this study is to learn about the differences between pre-eclamptic and normotensive pregnant women in relation to these hematological parameters. Thus, the study aims to provide an inexpensive and clinically significant means for identifying women who are pre-eclampsia high risk by determining the parameters' eclamptic potential diagnosis and predictive value. Most of Group A were aged 21-30, while most Group B were aged 18-25, corroborating Gogoi P et al findings, who observed similar mean ages between pre-eclamptic and control groups ($p > 0.05$).

In respect to parity, there were 31 women (47%) in Group A and 25 women (38%) in Group B, who were primigravida. This is different from the Hassan HES et al. study, where 22.5% of the healthy women and 40% of the women with pre-eclampsia were primigravida. [12] Primigravida women have greater pre-eclampsia risk than multiparous women, as immune tolerance established during the first pregnancy attributes for lower risk in future pregnancies, if the first pregnancy was uncomplicated. This is in line with Grum T et al. study where it was reported that primigravida women had 2.68 times higher odds of pre-eclampsia than multigravida women. [13] In the current study, the women with pre-eclampsia had lower platelet counts (PC) than the normotensive controls, which is similar to the works of Mohapatra S et al. and Annam V et al. [14,15] At the same time, the platelet parameters were higher in pre-eclampsia and eclampsia-- mean platelet volume (MPV), platelet distribution width (PDW), and platelet large cell ratio (PLCR). [16] Dogru HY et al. noted that lower platelet counts were found with higher mean platelet volumes in some cohorts of pregnant women.

Freitas LG et al. demonstrated that PDW was significantly higher in the pre-eclamptic group than in the normotensives and non-pregnant individuals ($p < 0.001$). Also in the severe form of pre-eclampsia, MPV was higher than in the normotensive and non-pregnant individuals ($p = 0.05$ and $p < 0.001$) [18]. The low platelet counts found in Pre-eclampsia are due to the activation of the endothelial cells and their dysfunction, which causes an increased consumption of the platelets. Several sources also demonstrated the pre-eclamptic patients had an increased mean platelet volume. This has also been described by Chirag Buch A et al., Gioia S et al., and Özdemirci S et al. [17,19,20]. Kanat-Pektas M et al. stated that an MPV of 10.1 or more, along with low PAPP-A levels, could predict pre-eclampsia with high accuracy [21]. Other authors Yang SW et al. and Bellos I et al. also stated that MPV was a reasonable predictor of pre-eclampsia [22,23].

Conclusion:

The present study found that platelet count (PC) was reduced, while platelet indices such as mean platelet volume (MPV) and platelet distribution width (PDW) were elevated in the pre-eclampsia group compared to normotensive pregnant women, with these differences being statistically significant. These findings suggest that platelet indices may serve as useful prognostic markers for predicting pre-eclampsia and could contribute to improving maternal and fetal outcomes. However, further multicenter studies with larger sample sizes and longer follow-up are needed to validate these results in this population.

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