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Significance of Platelet Count and Platelet Indices for Assessing the Presence and Severity of Preeclampsia: An Analytical Cross-Sectional Study

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ABSTRACT

Background and aim: Preeclampsia is a multisystem hypertensive disorder of pregnancy associated with considerable maternal and perinatal morbidity and mortality. Platelet activation and increased platelet consumption are key features of its pathophysiology and may be reflected by alterations in platelet count and platelet indices. This study evaluated the clinical significance of platelet count, mean platelet volume (MPV), platelet distribution width (PDW), and plateletcrit (PCT) in women with preeclampsia and their association with disease severity.

Material and methods: In this analytical cross-sectional study, 100 pregnant women (50 normotensive controls and 50 with preeclampsia) were recruited from M.B. Government Hospital and R.N.T. Medical College, Udaipur, India. Platelet parameters were measured using an automated haematology analyser. Statistical analyses included one-way ANOVA, Pearson's correlation, and ROC curve analysis.

Results: Women with preeclampsia had significantly lower platelet counts than controls, with a further decline as disease severity increased ($p<0.001$). MPV and PDW increased significantly with worsening disease severity ($p=0.024$ and $p=0.001$, respectively), whereas PCT showed no significant difference between groups ($p=0.853$). ROC analysis demonstrated moderate diagnostic performance for platelet count (AUC=0.75) and PDW (AUC=0.73), while MPV and PCT showed lower discriminatory value.

Conclusions: Platelet count and PDW are inexpensive, readily available biomarkers that may assist in assessing preeclampsia severity. However, given their moderate diagnostic accuracy and the cross-sectional design of this study, they should be considered complementary to established diagnostic criteria. Larger prospective multicentre studies are needed to confirm these findings before routine clinical use.

1. Introduction

Preeclampsia is a potentially life-threatening complication of pregnancy characterized by new-onset hypertension after 20 weeks of gestation, accompanied by maternal organ dysfunction, Thrombocytopenia, or fetal growth restriction.[1-3] It remains one of the leading causes of maternal and perinatal morbidity and mortality worldwide, affecting approximately 2%–8% of pregnancies globally and up to 8%–10% of pregnancies in India.[4] Despite advances in obstetric care, preeclampsia continues to contribute substantially to adverse maternal and neonatal outcomes, including eclampsia, preterm birth, placental abruption, fetal growth restriction, and perinatal death. The diagnosis of preeclampsia is based on persistent hypertension (blood pressure ⩾140/90 mmHg after 20 weeks of gestation) in association with proteinuria or evidence of maternal end-organ dysfunction.[5] According to the American College of Obstetricians and Gynecologists (ACOG), severe features include systolic blood pressure ⩾160 mmHg or diastolic blood pressure ⩾ 110 mmHg, Thrombocytopenia, renal insufficiency, impaired liver function, pulmonary oedema, or new-onset cerebral or visual disturbances.[6] Although these diagnostic criteria are well established, identifying simple laboratory parameters that reflect disease severity remains an important clinical objective. The exact pathophysiological mechanisms underlying preeclampsia are not yet fully understood. However, abnormal placentation, impaired spiral artery remodeling, placental hypoperfusion, oxidative stress, systemic endothelial dysfunction, and an exaggerated maternal inflammatory response are recognized as central mechanisms.[7] Endothelial injury promotes platelet activation and accelerated platelet consumption, leading to compensatory release of larger and younger platelets from the bone marrow. Consequently, alterations in platelet count and platelet indices including mean platelet volume (MPV), platelet distribution width (PDW), and plateletcrit (PCT) may reflect the severity of platelet activation and endothelial dysfunction in

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preeclampsia. Thrombocytopenia is the most common haematological abnormality associated with this disorder.[8] Several previous studies have demonstrated significant alterations in platelet indices among women with preeclampsia and have suggested their potential utility as inexpensive biomarkers for disease prediction and severity assessment.[9, 10] Nevertheless, published findings remain inconsistent, particularly regarding the diagnostic performance of MPV and PCT, and variations in study populations, laboratory methodologies, and diagnostic thresholds have limited the generalisability of existing evidence.[11] Furthermore, relatively few studies have simultaneously evaluated platelet count together with multiple platelet indices using receiver operating characteristic (ROC) analysis to determine their comparative diagnostic accuracy. Therefore, an important knowledge gap remains regarding which platelet parameter provides the greatest clinical value for identifying disease severity and whether these routinely available haematological indices can serve as reliable adjunctive markers in routine obstetric practice. Based on the underlying pathophysiology of platelet activation in preeclampsia, we hypothesized that platelet count would progressively decrease. In contrast, MPV and PDW would increase with increasing disease severity, and selected platelet indices would demonstrate acceptable diagnostic performance for differentiating severe preeclampsia from normotensive pregnancy. Accordingly, the present study aimed to compare platelet count and platelet indices between normotensive and preeclamptic pregnant women, evaluate their relationship with disease severity, and assess their diagnostic performance using ROC curve analysis.

2. Material and methods

Study design and setting

This hospital-based, analytical, cross-sectional study was conducted in the Department of Pathology, in collaboration with the Departments of Obstetrics and Gynecology at Maharana Bhupal Government Hospital and R.N.T. Medical College, Udaipur, Rajasthan, India. The study was carried out after obtaining Institutional Ethics Committee approval (Approval No.: [Insert Approval Number]). Written informed consent was obtained from all participants before enrolment.

Study population

A total of 100 pregnant women with singleton pregnancies beyond 20 weeks of gestation were enrolled consecutively during the study period. Participants were allocated into two groups:

Group I: 50 normotensive pregnant women (control group)

Group II: 50 women diagnosed with preeclampsia according to the American College of Obstetricians and Gynecologists (ACOG) criteria.[6]

To minimize selection bias, eligible participants were recruited consecutively until the required sample size was achieved.

Sample size

The sample size was calculated using the formula for comparing two independent proportions based on the reported prevalence of thrombocytopenia among women with preeclampsia (26.6%) and normotensive pregnant women (5%).[21] After considering a statistical power of 80%, a confidence level of 95%, and an anticipated 10% non-response rate, the minimum required sample size was calculated as 45 participants per group. To improve statistical reliability and compensate for potential incomplete data, 50 participants were ultimately included per group, resulting in a total sample of 100 women.

Inclusion criteria (Cases)

Women were eligible if they fulfilled all of the following criteria:

Age ⩾18 years

Singleton pregnancy

Gestational age ⩾20 weeks

Primigravida

Diagnosis of preeclampsia according to ACOG criteria (blood pressure ⩾ 140/90 mmHg on two occasions at least 4 hours apart with proteinuria or other diagnostic features).[6]

Exclusion criteria (Cases)

Women with any of the following conditions were excluded:

Chronic hypertension

Diabetes mellitus

Chronic kidney disease

Pre-existing haematological disorders

Previous history of preeclampsia

Autoimmune disorders

Current anticoagulant therapy

Multiple pregnancy

Control group

Normotensive pregnant women aged ⩾ 18 years with singleton pregnancies beyond 20 weeks of gestation and blood pressure <140/90 mmHg were enrolled as controls. Women with hypertension, diabetes, renal disease, haematological disorders, autoimmune diseases, or multiple gestations were excluded.

Clinical assessment

Demographic and clinical information, including maternal age, gestational age, parity, blood pressure, and relevant obstetric history, was recorded using a structured data collection form. Blood pressure was measured using a calibrated mercury sphygmomanometer with participants seated after at least 10 minutes of rest. Two measurements were obtained at least 4 hours apart, and the average was used for analysis. Urinary protein was assessed using a standard dipstick method.

Blood sample collection and laboratory analysis

Approximately 3 mL of venous blood was collected under aseptic conditions into EDTA-anticoagulated tubes. All samples were analyzed within two hours of collection to minimize platelet swelling and pre-analytical variability. Complete blood count and platelet indices were measured using the fully automated Yumizen H550 five-part differential haematology analyser (Horiba Medical, Montpellier, France), operating on the Coulter impedance principle. The analyzer underwent routine internal quality control according to the manufacturer's recommendations before daily sample processing.

The following platelet parameters were recorded:

- Platelet Count (PC)
- Mean Platelet Volume (MPV)
- Platelet Distribution Width (PDW)
- Plateletcrit (PCT)

To reduce analytical variability, all measurements were performed in the same laboratory using identical equipment and standard operating procedures.

Statistical analysis

Statistical analyses were performed using SPSS software version 16.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages. The normality of continuous variables was assessed using the Shapiro–Wilk test. Comparisons among normal pregnancy, mild preeclampsia, and severe preeclampsia were performed using one-way analysis of variance (ANOVA), followed by Tukey's post hoc multiple-comparison test when significant differences were observed. Categorical variables were compared using the Chi-square test or Fisher's exact test where appropriate. Pearson's correlation coefficient was used to evaluate the relationships between platelet parameters and blood pressure measurements. Receiver operating characteristic (ROC) curve analysis was performed to determine the diagnostic performance of platelet parameters. The area under the curve (AUC), sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and optimal cut-off values based on the Youden Index were calculated. A two-sided p-value <0.05 was considered statistically significant.

3. Results

Participant characteristics

A total of 100 pregnant women were enrolled in the study, including 50 normotensive pregnant women and 50 women diagnosed with preeclampsia. Among the preeclamptic group, 14 (28%) had mild preeclampsia, whereas 36 (72%) had severe preeclampsia. The mean age of women in the normotensive group was 26.7 ± 5.5 years (range: 18–44 years), compared with 28.2 ± 5.7 years (range: 18–47 years) in the preeclampsia group. Although women with preeclampsia were slightly older, the difference in age distribution between the two groups was not statistically significant (p >0.05).

Table 1. Age-wise distribution of participants (n = 100).

Age Group (years)	Normotensive Women n (%)	Preeclamptic Women n (%)	Total n (%)
<20	2 (4.0)	3 (6.0)	5 (5.0)
21–25	14 (28.0)	10 (20.0)	24 (24.0)
26–30	18 (36.0)	16 (32.0)	34 (34.0)
31–35	5 (10.0)	16 (32.0)	21 (21.0)
>35	11 (22.0)	5 (10.0)	16 (16.0)
Total	50 (100)	50 (100)	100 (100)

Blood pressure parameters

All normotensive pregnant women had systolic BP <140 mmHg and diastolic BP <90 mmHg. Among preeclamptic women, 33 (66%) had systolic BP ⩾160 mmHg and 24 (48%) had diastolic BP ⩾110 mmHg. Of the 50 preeclamptic women, 14 (28%) had mild preeclampsia and 36 (72%) had severe preeclampsia. The mean systolic BP in normotensive women was 113.42 ± 10.46 mmHg, versus 160.76 ± 16.09 mmHg in preeclamptic women, and the mean diastolic BP was 72.24 ± 8.45 mmHg versus 105.64 ± 11.40 mmHg, respectively. Both differences were highly statistically significant (p <0.001).(Table 2)

Table 2. Comparison of mean blood pressure between normotensive and preeclamptic women.

Parameter	Normotensive Women Mean ± SD	Preeclamptic Women Mean ± SD	Mean Difference	P-value
Systolic BP (mmHg)	113.42 ± 10.46	160.76 ± 16.09	47.34	<0.001
Diastolic BP (mmHg)	72.24 ± 8.45	105.64 ± 11.40	33.40	<0.001

Platelet count and platelet indices

Platelet count showed a statistically significant progressive decrease from normal pregnancy (212.8 ± 59.3 $\times 10^3/\mu L$) to mild preeclampsia (182.5 ± 48.8 $\times 10^3/\mu L$) and severe preeclampsia (157.1 ± 49.6 $\times 10^3/\mu L$) (p <0.001). Thrombocytopenia (<100 $\times 10^3/\mu L$) was exclusively observed in severe preeclampsia (4 cases, 11.1%); however, the low incidence (11.1%) should be interpreted with caution given the small sample size. MPV and PDW demonstrated significant increases with severity (p = 0.024 and p = 0.001, respectively). It should be noted that PDW is reported here in fL as generated by the Yumizen H550 analyzer; some instruments report PDW as a percentage, and readers should consider this when comparing across studies. PCT showed no statistically significant difference across groups (p =0.853). (Table 3)

Table 3. Comparison of platelet parameters across normal pregnancy, mild and severe preeclampsia.

Parameter	Normal Pregnancy (n=50) Mean ± SD	Mild Preeclampsia (n=14) Mean ± SD	Severe Preeclampsia (n=36) Mean ± SD	P-value*
Platelet Count (×10³/µL)	212.8 ± 59.3	182.5 ± 48.8	157.1 ± 49.6	<0.001
PCT (%)	0.205 ± 0.067	0.198 ± 0.089	0.196 ± 0.075	0.853
MPV (fL)	10.37 ± 1.78	9.90 ± 2.00	11.16 ± 1.22	0.024
PDW (fL)	18.20 ± 5.00	17.51 ± 4.44	21.61 ± 3.94	0.001

*p-value by one-way ANOVA. MPV: Mean Platelet Volume; PDW: Platelet Distribution Width; PCT: Plateletcrit.

Correlation analysis

Pearson's correlation analysis in normotensive pregnant women revealed significant negative correlations between platelet count and MPV ($r = -0.376$, $p = 0.007$) and between platelet count and PDW ($r = -0.483$, $p < 0.001$). A strong positive correlation between platelet count and PCT was observed across all study groups ($p < 0.01$). In mild preeclampsia, PDW demonstrated a significant positive correlation with diastolic blood pressure ($r = 0.729$, $p = 0.003$). No significant correlation between platelet parameters and blood pressure was observed in either the normotensive or the severe preeclampsia groups. It is acknowledged that no correction for multiple comparisons (e.g., Bonferroni correction) was applied in this analysis, which may increase the risk of type I error; results should therefore be interpreted with appropriate caution. (Table 4)

Table 4. Significant correlations between platelet parameters and blood pressure.

Variables	P-value	r
Platelet Count vs MPV	0.007	−0.376
Platelet Count vs PDW	<0.001	−0.483
Platelet Count vs PCT	<0.01	Positive
PDW vs Diastolic BP (Mild PE)	0.003	0.729

Diagnostic performance (ROC analysis)

ROC curve analysis was performed to evaluate the diagnostic performance of platelet parameters in differentiating severe preeclampsia from normotensive pregnancies. Platelet count demonstrated good diagnostic accuracy (AUC = 0.75; 95% CI: 0.64–0.85), with a cut-off of <164 ×10³/µL yielding a sensitivity of 58.3% and a specificity of 80.0%. PDW showed an AUC of 0.73 (95% CI: 0.62–0.83) at a cut-off of >18.6 fL (sensitivity 80.6%, specificity 64.0%). MPV showed moderate performance (AUC = 0.65); notably, it demonstrated 100% sensitivity but 34.0% specificity, suggesting it may be better suited as a rule-out rather than a confirmatory marker, and its clinical utility should be interpreted accordingly. At the same time, PCT had poor discriminatory value (AUC = 0.49). (Table 5)

Table 5: Diagnostic Performance of Platelet Parameters -Severe Preeclampsia vs. Normotensive Pregnancy.

Parameter	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Cut-off	AUC (95% CI)
Platelet Count	58.3	80.0	67.7	72.7	<164 ×10³/µL	0.75 (0.64–0.85)
MPV (fL)	100.0	34.0	52.2	100.0	>9.5 fL	0.65 (0.53–0.77)
PDW (fL)	80.6	64.0	61.7	82.1	>18.6 fL	0.73 (0.62–0.83)
PCT (%)	44.4	66.0	48.5	62.3	>0.228%	0.49 (0.37–0.62)

PPV: Positive Predictive Value; NPV: Negative Predictive Value; AUC: Area Under the Curve; MPV: Mean Platelet Volume; PDW: Platelet Distribution Width; PCT: Plateletcrit.

4. Discussion

Preeclampsia is a significant hypertensive disorder of pregnancy associated with considerable maternal and fetal morbidity and mortality.[12] It is characterized by widespread endothelial dysfunction and abnormal placentation, leading to altered haematological parameters, particularly platelet parameters. Platelet activation, increased consumption, and accelerated turnover are key features of its pathophysiology, reflected in changes in platelet count, MPV, PDW, and PCT.[7, 23] In the present study, the majority of preeclamptic women were in the 26–35-year age group (64%), with a mean age of 28.2 ± 5.7 years, slightly higher than that of the normotensive group (26.7 ± 5.5 years). These findings are consistent with previous studies reporting a higher mean age among women with preeclampsia, with the majority of cases occurring in the 26–35-year age group.[13, 14, 26] Mean platelet count was significantly lower in preeclamptic women (164.21 ± 50.15 $\times 10^3/\mu L$) compared with normotensive women (212.8 ± 59.3 $\times 10^3/\mu L$), declining progressively from mild to severe preeclampsia ($p < 0.001$). These findings are consistent with previous studies reporting significantly reduced platelet counts in women with preeclampsia.[8, 22-24] Thrombocytopenia was observed exclusively in severe preeclampsia cases (11.1%), consistent with previous studies.[19, 20] MPV was elevated in preeclamptic women (10.81 ± 1.54 fL) compared to normotensive women (10.37 ± 1.78 fL) and increased significantly with disease severity ($p = 0.024$), consistent with previous studies.[8, 22-24] The elevated MPV reflects enhanced platelet activation and accelerated bone marrow turnover secondary to endothelial injury in preeclampsia.[15, 17] PDW showed a significant increase with preeclampsia severity, from 18.20 ± 5.00 fL in normotensive women to 21.61 ± 3.94 fL in severe preeclampsia ($p = 0.001$). PDW reflects platelet size heterogeneity and is a marker of platelet activation and coagulation.[16, 18] These observations are consistent with previous studies.[8, 22, 24] PCT did not show a statistically significant difference among the three groups ($p = 0.853$), consistent with previous findings.[20, 22] Although platelet count declined in preeclampsia, the compensatory increase in platelet volume partly maintained PCT, limiting its diagnostic utility. Several limitations of this study should be acknowledged. The relatively small sample size (n = 100) and single-centre design may limit the generalisability of findings. The consecutive sampling method may introduce selection bias. No correction for multiple comparisons was applied to the correlation analysis. Longitudinal follow-up was not performed to assess predictive utility over time. Future large-scale, multicentre studies with prospective designs are warranted to validate these findings. ROC analysis demonstrated that platelet count (AUC = 0.75) and PDW (AUC = 0.73) were the best predictors of severe preeclampsia, outperforming MPV (AUC = 0.65) and PCT (AUC = 0.49). These findings suggest the potential role of platelet count and PDW as cost-effective, readily available markers for assessing severity in preeclampsia.

5. Conclusion

The present study demonstrates that significant alterations in platelet indices occur in preeclampsia and are associated with disease severity. Platelet count decreases progressively while MPV and PDW increase from mild to severe preeclampsia, indicating enhanced platelet activation and consumption. PCT showed limited diagnostic usefulness. Platelet count and PDW demonstrated moderate diagnostic performance (AUC 0.75 and 0.73, respectively) and may be considered potentially useful, inexpensive, and readily available adjuncts for severity assessment of preeclampsia, pending further validation. Routine assessment of platelet indices as part of a complete blood count may provide additional clinical information in the management of hypertensive disorders of pregnancy. Further large-scale, multicentre, prospective studies are recommended to validate their prognostic and predictive roles.

Conflict of Interest

The authors declared that there is no conflict of interest.

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