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A Cross Sectional Study to Evaluate the Association of Platelet Indices in Preeclampsia and Healthy Pregnancy.

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Abstract

Background and Objective: Preeclampsia is a major hypertensive disorder of pregnancy associated with substantial maternal and fetal morbidity and mortality. Platelet activation and increased platelet consumption are well known features of its pathophysiology and platelet indices are potential biomarkers for diagnosis and assessment of disease severity. In this study, we evaluated the association of platelet indices with preeclampsia and healthy pregnancies. ***Materials and Methods:*** The present cross-sectional study involved 90 pregnant women >20 weeks of gestation, of whom 50 had preeclampsia and 40 were normotensive controls. Clinical details, blood pressure and urine protein levels were documented. Platelet indices were measured on an automated Sysmex hematology analyzer. Statistical analysis was performed and p-value <0.05 was considered statistically significant. ***Results:*** Women with preeclampsia had significantly higher mean platelet volume (MPV) and platelet distribution width (PDW) compared to normotensive controls (MPV: 9.8 vs 8.7 fL; PDW: 13.5 vs 12.1 fL; $p < 0.001$). Also, Plateletcrit (PCT) was significantly different between the groups ($p < 0.001$). The platelet count was lower in the preeclampsia group, but it was not statistically significant. MPV had the best diagnostic performance with sensitivity of 81% and specificity of 85% followed by PCT (sensitivity 78%) and PDW (sensitivity 72%). Platelet count had the highest specificity (95%) but relatively lower sensitivity (73%). ***Conclusion:*** MPV, PDW and PCT are more sensitive indicators of platelet activation in preeclampsia than platelet count alone and can be useful adjunctive biomarkers for early diagnosis and evaluation. The use of these cheap and easily available platelet indices in antenatal assessment may help in identifying the women at risk earlier and thus improving maternal and fetal outcomes. These findings need to be confirmed in larger multicenter prospective studies.

Keywords: Preeclampsia, Platelet indices, Maternal health, Diagnostic Biomarkers, Pregnancy.

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INTRODUCTION

Two to eight percent of pregnant women develop preeclampsia. It ranks second in maternal mortality worldwide after hemorrhagic diseases.High blood pressure and proteinuria or organ dysfunction usually appear after 20 weeks of gestation.[2,3] Often, endothelial dysfunction, inflammation, and abnormal placentation cause systemic vasoconstriction and increased vascular permeability in preeclampsia.[4-7] The hematological change thrombocytopenia in preeclampsia indicates increased platelet consumption and activation.[8] Platelet indices may be biomarkers for preeclampsia detection and monitoring. Routine blood tests can measure platelet count (PC), MPV, PDW, and PCT, which reveal platelet activation and turnover.Preeclampsia has serious health consequences, so early detection and treatment are essential. This study examines how platelet indices like MPV, PDW, and PCT predict preeclampsia occurrence and severity. These indices' diagnostic accuracy will be assessed to determine if they can improve prenatal care and maternal and fetal outcomes.

MATERIALS AND METHODS

Study Design and Setting

A cross-sectional study was conducted in the Department of Pathology at the Bangalore Medical College and Research Institute (BMCRI). The study was initiated following formal clearance from the institutional ethical committee. The study population comprised pregnant women attending the antenatal clinic in the Department of Obstetrics and Gynaecology who provided informed consent to participate.

Sample Size Calculation
The sample size was determined based on previous literature by Bawore SG. et al., which reported mean platelet counts in normotensive and preeclamptic pregnant women as 251 ± 76.5 × 10^3/µL and 170 ± 63.8 × 10^3/µL, respectively. Assuming a minimum expected difference of 30 × 10^3/µL between the two groups, the required sample size was calculated to be 86. To account for potential dropouts and improve statistical reliability, this was rounded up to a total of 90 participants, comprising 50 cases and 40 controls.

Study Population
Participants were recruited based on the following criteria:

Inclusion Criteria:
Women with singleton pregnancies beyond 20 weeks of gestation.
Cases: Pregnant women diagnosed with preeclampsia in accordance with the National Institute for Health and Care Excellence (NICE) 2010 guidelines (blood pressure ≥140/90 mmHg after 20 weeks of pregnancy with the presence of proteinuria).

Controls: Healthy pregnant women with singleton pregnancies, normal blood pressure limits, and no evidence of proteinuria.
Hospitalized pregnant women who provided explicit informed consent.

Exclusion Criteria:
Patients with gestational or insulin-dependent diabetes and known pre-existing hypertension.
Multiple gestations.
Patients with a history of preeclampsia, renal or hepatic dysfunction, or disseminated intravascular coagulation (DIC).
Patients receiving medications known to alter platelet counts, such as heparin or corticosteroids.

Data Collection and Methodology
Informed consent was obtained from all individual participants prior to enrollment. Demographic data, detailed clinical history, blood pressure readings, and urine albumin levels were systematically recorded for all participants. Venous blood samples were collected and subsequently analyzed for platelet indices utilizing an automated Sysmex hematology analyzer.

Outcome Measures
Primary Outcome: To evaluate the differences in platelet indices between the preeclampsia (cases) and normotensive (control) groups.
Secondary Outcome: To assess the correlation of platelet indices with the severity of preeclampsia.

Statistical Analysis
Data were analyzed using Statistical Package for the Social Sciences (SPSS) software, version 21.0. Descriptive statistics were utilized to summarize the data, including mean, median, standard deviation, inter-quartile range, and percentages, presented alongside relevant tables and graphs.

Inferential statistics included the following tests:
An Independent T-test was performed to determine significant differences in platelet indices between preeclamptic and normotensive pregnant women.

An ANOVA test was utilized to evaluate significant differences in platelet indices across three groups: normotensive, non-severe preeclampsia, and severe preeclampsia.
The Pearson correlation coefficient (r) was calculated to estimate the strength of the association between individual platelet indices and mean arterial pressure (MAP).

Receiver Operating Characteristic (ROC) curve analysis was conducted to estimate the sensitivity of platelet indices as severity markers for preeclampsia.

Standard diagnostic indices, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), were calculated to determine the diagnostic potential of the indices.
Statistical significance was defined as a p-value of < 0.05 for all analyses.

RESULTS

In our study of 90 pregnant women (50 with preeclampsia and 40 controls), age, gravidity, and parity were similar across groups with no statistical significance (Table 1).

Table 1: Clinical characteristics of study participants

Characteristics	Normotensive (n=40)	Non severe Preeclampsia (n=29)	Severe preeclampsia (n=21)
Age	25.1 (21-31)	27.3 (22-35)	26.2 (20-37)
Gravidity	1 (1-4)	2 (1-5)	2 (1-4)
Parity	1(0-3)	1 (0-3)	1 (0-3)
SBP	116.7 (110-120)	145.2 (130-180)	158.7 (130-190)
DBP	78.4 (74-82)	93.3 (80-120)	101.7 (90-120)
MAP	87.8 (83.1-93.3)	108.6 (96-133.3)	120.89 (108-173.3)
Proteinuria	0	2+(1-3)	3+(1-3)

Blood pressure increased with preeclampsia severity: systolic (116.7 mmHg in controls vs. 158.7 mmHg in severe cases) and diastolic pressures showed similar trends (Tables 2 and 3).

Table 2: Comparisons of blood pressure between normotensive and PE

BP	Normotensive	Preeclampsia	*P value*
SBP	116.7 (110-120)	150.9 (130-190)	*<0.001*
DBP	78.4 (74-82)	96.8 (80-120)	*<0.001*
MAP	87.8 (83.1-93.3)	114.5 (96.6-143.3)	*<0.001*

Table 3: Comparisons of blood pressure between non severe and severe PE

BP	Non severe preeclampsia	Severe preeclampsia	p value
SBP	145.2 (130-180)	158.7 (130-190)	<0.001
DBP	93.3 (80-120)	101.7 (90-120)	<0.001
MAP	108.6 (96-133.3)	120.89 (108-143.3)	<0.001

Platelet indices, particularly MPV and PDW were significantly higher in preeclamptic women compared to controls (MPV: 9.8 vs. 8.7 fl; PDW: 13.5 vs. 12.1 fl; both *P<0.001*). Sensitivities for MPV and PDW were 81% and 72%, respectively. MPV was significantly higher in the preeclampsia group (mean = 9.8 fl) compared to the control group (mean = 8.7 fl) (*P<0.001*). PDW was also significantly elevated in the preeclampsia group (mean = 13.5fL) compared to controls (mean = 12.1%fL) (*P<0.001*). PCT was also significantly elevated in the preeclampsia group (mean = 0.16%) compared to controls (mean = 0.22%) (*P<0.001*). The mean platelet count was slightly lower in the preeclampsia group (mean = 202 x 10^9/L) compared to controls (mean = 217 x 10^9/L), but this difference was not statistically significant (*P>0.05*) (Tables 4 and 5).\

Table 4: Comparisons of platelet indices between normotensive and pre-eclamptic pregnant women

Platelet indices	Normotensive	Preeclampsia	p value
PC(x10^3/μm)	217 (130-380)	202 (60-441)	>0.05
MPV (fL)	8.7 (6.7-11.4)	9.8 (7.3-11.5)	<0.001
PDW (fL)	12.1 (7.4-13.4)	13.5 (8.4-17.8)	<0.001
PCT (%)	0.17 (0.15-0.34)	0.18 (0.05-0.24)	<0.001

Table 5: Comparisons of platelet indices among normotensive, non-severe, and severe pre-eclamptic pregnant mothers

Platelet indices	Normotensive pregnant women (n=40)	Non-severe pre-eclampsia group (n=29)	Severe pre-eclampsia group (n=21)	p value
Platelet count (x10^3/μm)	217 (130-380)	236 (78-432)	214 (60-441)	>0.05
MPV (fL)	8.7 (6.7-11.4)	9.2 (7.7-11.4)	9.3 (7.3-11.5)	<0.001
PDW (fL)	12.1 (7.4-13.4)	12.7 (8.9-17.8)	12.6 (8.4-15.4)	<0.001
PCT (%)	0.17 (0.15-0.34)	0.17 (0.06-0.24)	0.15 (0.05-0.24)	<0.001

Diagnostic accuracy of platelet indices (Table 6):

Platelet Count: The sensitivity of platelet count at a cutoff value of <170 x 10^3/μL was 73%, with a specificity of 95%, a positive predictive value (PPV) of 95.6%, and a negative predictive value (NPV) of 75.3%.

MPV: The sensitivity of MPV at a cutoff value of >8.2 fL was 81%, with a specificity of 85%, a PPV of 76.4%, and a NPV of 88.3%.
PDW: Using a cutoff value of >12 fL, PDW had a sensitivity of 72%, specificity of 83%, PPV of 83.7%, and NPV of 70.2%.
PCT: With a cutoff value of <0.19%, PCT showed a sensitivity of 78%, specificity of 70%, PPV of 76.5%, and NPV of 71.2%.

Table 6: Diagnostic Accuracy of platelet indices (PPV: Positive predictive value, NPV: Negative predictive value)

Parameters (cutoff value)	PC (<170x103/µm)	MPV (>8.2fL)	PDW (>12fL)	PCT(<0.19%)
Sensitivity	73%	81%	72%	78%
Specificity	95%	85%	83%	70.00%
PPV	95.60%	76.40%	83.70%	76.50%
NPV	75.30%	88.30%	70.20%	71.20%

DISCUSSION

Chung and Lee assert that MPV, PDW, and PCT are good biomarkers for the prediction of preeclampsia in an Asian population. Thus, we can conclude that platelet indices may be useful diagnostic markers in heterogeneous populations.[10] Muzaffer Temur et al. found that the mean platelet volume (MPV) of preeclamptic patient (9.66 ± 1.62 fl) was significantly higher than normotensive controls (8.92 ± 1.33 fl, $p < 0.001$).[11] This was similar to our study as in our study the MPV of preeclamptic patients (9.8 fl) was greater than the MPV of normotensive patient (8.7 fl).

The high levels of MPV in preeclampsia show disturbance in the platelet production and function because of it. The findings from the meta-analysis of Kocabay & Erdogan supports our results, further highlighting the importance of MPV for predicting preeclampsia.[12]

Nitesh Thalor et al. also found the MPV significantly increased in preeclamptic patients which further validates our findings.[13] Shaifali Dadhich et al. found 44.5% increase in MPV in preeclamptic patients while it was 9.22% in normotensive control patients.[4] This strengthens our finding that MPV is a good indicator of preeclampsia and can be used for early diagnosis.

Bawore et al. showed significant increment in PDW and MPV with the severity of preeclampsia.9 The area under the curve (AUC) of PDW for predicting preeclampsia was 0.986, confirming its excellent diagnostic value. According to our study findings, statistically significant differences were observed in MPV and platelet count across different severity of pre-eclampsia. Moreover, Tunc & Dogan stated that platelet indices aid in the early diagnosis of preeclampsia and are correlated with severity. This has been confirmed by our findings related to the diagnostic performance of MPV and PDW.[14].

The finding of an increase in MPV among women with preeclampsia indicates that larger and active platelets may be involved in the disease process. This finds a support in the literature that documents the association of MPV with platelet activation disorders and thrombotic disorders. In preeclampsia, increased PDW is seen due to rise in platelet production related to consumption from endothelium damage, this causes a prothrombotic state in the disease.

CONCLUSION

MPV, PDW, and PCT seem to be more effective markers for detection of preeclampsia in comparison to platelet count in view of the case of increased platelet activation and turnover in case of preeclamptic patients. According to the results of the study, these indices are useful in diagnosing and prognosticating preeclampsia. The similarity of the different studies, including this one, highlights the importance of MPV and PDW as biomarkers for preeclampsia. Higher mean platelet volume (MPV) seems a reliable and early indicator for managing preeclampsia along with blood pressure tests in patients and general populations. It is recommended that these indices continue to be optimized in further scientific studies and that they be applied for routine use in affected pregnancies.

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Reviewed And Edited The Manuscript. S.M.A. Contributed To The Study Design, Interpretation Of Results, And Critical Revision Of The Manuscript. All Authors Read And Approved The Final Manuscript.

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