International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

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Diagnostic and prognostic value of Platelet Indices as a potential biomarker in Preeclampsia: A Case-Control Study in a maternity hospital at Tashkent

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International Journal of Science and Research Archive, 2025, 14(03), 398-403

Publication history: Received on 26 January 2025; revised on 03 March 2025; accepted on 05 March 2025

Article DOI: https://doi.org/10.30574/ijsra.2025.14.3.0640

Abstract

Background: Preeclampsia (PE) is a significant pregnancy complication which is responsible for maternal and fetal morbidity and mortality worldwide. Overall 10 to 15% of direct maternal mortality is linked with preeclampsia and eclampsia. It is characterized by the new onset of hypertension and proteinuria after 20 weeks of gestation period. The objective of this study is to analyse whether platelet count (PC), mean platelet volume (MPV), and platelet distribution width (PDW) is involved in the onset of preeclampsia in patients and evaluate their correlation with the severity of disease.

Methods: A case-control study was conducted at Tashkent in 58 pregnant women, among them 28 was preeclamptic (mild: n=15, severe: n=13) and 30 age-matched normotensive controls. Platelet indices on complete blood count (CBC). Data was analyzed using MS-excel and SPSS.

Results: Platelet count was significantly low in preeclamptic patients compared to controls, lowest in severe preeclampsia. MPV and PDW were grossly elevated in preeclampsia ($p<0.001$) with an increasing trend in severe preeclampsia. MPV was positively correlated with systolic blood pressure ($r=0.56$, $p=0.001$), while PDW also moderately correlated with hypertension ($r=0.46$, $p=0.013$).

Conclusion: Platelet indices, particularly MPV and PDW, can be used as potential severity markers in preeclampsia. Their prognostic implications in clinical practice can help in early risk stratification and management and prevent impending eclampsia.

Keywords: Preeclampsia; Platelet count; Mean platelet volume; Platelet distribution width; Hypertension; pregnancy

1. Introduction

In modern obstetrics, multiple complications of pregnancy in women are observed in the second trimester [1]. Preeclampsia (PE) is a pregnancy-related complication leading to development of acute hypertensive condition that still continues to be a major concern for Obstetricians [2]. Preeclampsia affects 2% to 8% of all pregnancies and results in more than 70,000 maternal deaths and 500,000 fetal deaths worldwide every year [3]. Poor management of preeclampsia leads to eclampsia and even death [4]. Defined by the onset of hypertension (≥140/90 mmHg) and proteinuria (>300 mg/day) after 20 weeks of gestation, PE is associated with endothelial dysfunction, systemic inflammation, and coagulation abnormalities [5,6]. Women with PE present diverse signs and symptoms associated with multiple organ systems [7]. This disorder is a major cause of maternal and fetal morbidity and mortality [8].

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Platelets play a key role in its pathogenesis since their activation leads to increased consumption and abnormal values, which can be used as markers of disease progression. Many studies have reported the association between platelets and preeclampsia. However, sample sizes were small, and their findings were inconsistent [9].

Mean platelet volume (MPV) and platelet distribution width (PDW) are also the most important markers of platelet heterogeneity. Elevated MPV reflects the size of more active larger platelets, and elevated PDW reflects enhanced platelet heterogeneity, both of which have been linked to vascular function in preeclampsia [10]. Although the platelet indices have been mentioned in the context of hypertensive disorders, there is still no finding of how they forecast severity and complications in PE. The target of this study is to assess platelet indices in preeclampsia and determine their correlation with the severity of the disease, highlighting their prognostic significance.

2. Material and methods

Study Design and Population: Case-control study was conducted at Maternity hospital 3, Tashkent Medical Academy, enrolling 58 pregnant women into: two groups. Preeclampsia group (n=28): Classified according to ISSHP criteria. Divided into mild (n=15) and severe (n=13) cases. Control group (n=30): Age-matched normotensive pregnant women without proteinuria.

- **Inclusion Criteria:** Gestational age ≥ 20 weeks, IssHP criteria diagnostic for preeclampsia
- **Exclusion Criteria:** Pre-existing hypertension, chronic renal disease, gestational hypertension, Diabetes mellitus, Hematologic disorders in platelet indices, DIC
- **Data Collection and Analysis:** Gestational age and blood pressure were recorded. Platelet indices (PC, MPV, PDW) were added to CBC. Statistics were calculated using SPSS and Ms-excel. Continuous variables were expressed as mean ± SD and compared with the help of independent t-test. Correlation was quantified with Pearson's coefficient using scatter plots, the significance value being $p<0.05$.

3. Results

We studied the average age of patients in all study groups (Table 1.)

Table 1 Distribution of control and preeclamptic patients according to age group

Age Group (Years)	Control (n=30) (%)	Preeclampsia (n=28) (%)	P value
20–25 years	36.7% (11)	35.7% (10)	
26–30 years	40.0% (12)	39.3% (11)	
31–35 years	20.0% (6)	21.4% (6)	
Mean ± SD	27.0 ± 2.8	27.2 ± 3.7	0.078288

As shown in Table 1, the average age of patients did not differ in the average statistical ratio. This can be concluded that hypertensive conditions of pregnant women can occur in any age category, and has no age-specific values.When studying the gestational periods of pregnant women, no statistically significant indicators (p=0.84) were identified (Table 2).

Table 2 Distribution of control and preeclamptic patients according to gestational week

Gestational Week Range	Control (n=30) (%)	Preeclampsia (n=28) (%)	P value
20–24 weeks	30.0% (9)	28.6% (8)	
25–29 weeks	36.7% (11)	32.1% (9)	
30–34 weeks	30.0% (9)	32.1% (9)	
Mean ± SD	27.1 ± 3.8	27.3 ± 3.9	0.844094

Platelet indices, namely platelet count, mean platelet volume, platelet distribution width, and plateletcrit, were evaluated in both cases and controls. None of the patients had any evidence of thrombosis or organ damage. The PT/INR

was within the normal range. Thus, all the patients included in the study had mild to moderate preeclampsia. A study of the platelet count ($\times 10^9$/l) at different weeks of pregnancy in the examined groups revealed different indicators (Table 3).

Table 3 Platelet Count ($\times 10^9$/L) Across Gestational Weeks

Gestational Week Range	Control (Mean ± SD)	Preeclampsia (Mean ± SD)	p-value	T value, df, standard error
20–24 weeks	275.0±10.2	270.0±11.4	0.0834	95% confidence interval of this difference: t=1.7626, df=56standard error of difference=2.837
25–29 weeks	280.0±12.5	200.0±14.2	<0.001	95% confidence interval of this difference: t=22.8109, df=56standard error of difference=3.507
30–34 weeks	278.0±11.8	195.5±13.9	<0.001	95% confidence interval of this difference: t=24.4227, df=56standard error of difference=3.378

The platelet count was on the lower side in the patients with preeclampsia, as shown in Table 3, as compared to the healthy pregnant females, however none of the patients had severe thrombocytopenia. In our study, the difference with statistically significant p>0.05 was found in pregnant women at 20-24 weeks (p=0.08). But Drop in platelet count in 25 to 34 weeks is significantly correlated in control and case group (p<0.001).

The mean platelet volume (MPV) in pregnant women showed statistically significant signs (p<0.05) at all gestational weeks of pregnancy (Table 4).

Table 4 Mean Platelet Volume (MPV) (fL) Across Gestational Week

Gestational Week Range	Control (Mean ± SD)	Preeclampsia (Mean ± SD)	p-value	T value, df, standard error
20–24 weeks	9.6 ± 0.5	11.4 ± 0.6	<0.001	95% confidence interval of this difference: From -2.090 to -1.510 t = 12.4437 df = 56standard error of difference = 0.145
25–29 weeks	9.8 ± 0.6	11.9 ± 0.7	<0.001	95% confidence interval of this difference: From -2.442 to -1.758 Intermediate values used in calculations: t = 12.2925 df = 56standard error of difference = 0.171
30–34 weeks	9.9 ± 0.5	12.1 ± 0.6	<0.001	95% confidence interval of this difference: From -2.490 to -1.910 Intermediate values used in calculations: t=15.2090 df = 56standard error of difference=0.145

MPV was increased in women with preeclampsia compared to healthy pregnant women. The difference between the main group and the control group was statistically significant (p<0.001). The correlation coefficient r had a value of +0.42, indicating a positive correlation. Thus, it can be assumed that the increase in MPV values is directly proportional to the increase in blood pressure. And also according to Table 4, it can be found that the longer the gestation period, the higher the MPV values in pregnant women (p<0.001).

Similarly, platelet distribution width (PDW) increased in preeclampsia group when compared to normotensive pregnant women (p<0.001). The median value of the PDW was 16.9 fl in preeclampsia and 14.6 in normotensive patients, respectively and the difference was statistically significant (p<0.05), with higher values in preeclampsia (Table 5).

Table 5 Platelet Distribution Width (PDW) (%) Across Gestational Weeks

Gestational Week Range	Control (Mean ± SD)	Preeclampsia (Mean ± SD)	p-value	T value, df, standard error
20–24 weeks	14.4 ± 0.6	16.7 ± 0.7	<0.001	95% confidence interval of this difference:t = 13.4632, df = 56, standard error of difference = 0.171
25–29 weeks	14.6 ± 0.7	16.9 ± 0.8	<0.001	95% confidence interval of this difference: t = 11.6724df = 56standard error of difference = 0.197
30–34 weeks	14.7 ± 0.6	17.0 ± 0.7	<0.001	95% confidence interval of this difference: From -2.570 to -2.030Intermediate values used in calculations:t = 17.0492df = 56standard error of difference = 0.135

It was observed that the patients with higher elevations in BP had higher values of PDW. The correlation coefficient r was +0.47 and highly significant p-value, indicating that these results are consistent with the previous result. And there was a positive correlation between the increase in PDW and gestational age of women ($p<0.001$).

Platelet count in mild and severe preeclampsia has a decreasing trend across increasing gestational week, p value is significant ($p<0.05$) in mild and severe group in 25-29 and 30-34 weeks (Table 6). It is also possible to see a positive correlation with the severity of preeclampsia and the number of platelets ($p<0.05$). This indicates a deterioration in the condition of the pregnant woman with an increase in the severity of hypertensive conditions during pregnancy.

Table 6 Platelet Count ($\times 10^9$/L) Across Gestational Weeks for Mild and Severe Preeclampsia

Gestational Week Range	Mild preeclampsia (Mean ± SD)	Severe Preeclampsia (Mean ± SD)	p-value
20–24 weeks	230.1 ± 9.6	219.3 ± 8.2	0.080
25–29 weeks	211.1 ± 7.5	191.2 ± 7.8	0.040
30–34 weeks	197.3± 9.8	160.2 ± 12.1	0.002

Analysis of Mean Platelet Volume (MPV) in pregnant women with different degrees of preeclampsia severity revealed negative correlation indices (Table 7). Increased MPV was observed in severe preeclampsia, when compared with mild preeclampsia ($p<0.001$). P value for MPV in mild and severe preeclampsia shows highly significant correlation across all gestational weeks ($p<0.05$).

Table 7 Mean Platelet Volume (MPV) (fL) Across Gestational Weeks for Mild and Severe Preeclampsia

Gestational Week Range	Mild preeclampsia (Mean ± SD)	Severe Preeclampsia (Mean ± SD)	p-value
20–24 weeks	9.47 ± 0.19	10.16 ± 0.28	0.0003
25–29 weeks	10.00 ± 0.32	10.96 ± 0.23	0.001
30–34 weeks	10.54± 0.30	12.12± 0.30	0.0005

When determining the correlations between increased blood pressure in pregnant women with MPV and PDW, positive correlations were observed (Table 8).

Table 8 Pearson Correlation Coefficient of systolic BP with MPV and PDW

Parameter	Pearson correlation Coefficient (r)	t-value	P-value
MPV vs Systolic BP	+0.56	3.45	0.001
PDW vs Systolic BP	+0.46	2.64	0.0137

This may indicate the prediction of hypertensive changes in pregnant women with dynamic monitoring of the MPV and PDW level. These changes were statistically significant ($p<0.05$).

4. Discussion

The findings of the present study are consistent with earlier studies documenting outstanding alterations in platelet indices in preeclamptic women [6]. The mean platelet count reduction is consistent when stratified by gestational age, platelet count showed a progressive decline in preeclamptic patients , most significant decrease observed in severe preeclamptic group. The significant rise in MPV in preeclamptic patients, especially severe preeclampsia ($p<0.001$), is commensurate with its use as a marker of platelet activation. Increased MPV indicates metabolically active large platelets, and these are crucial in the prothrombotic state in PE [10]. The positive correlation between MPV and systolic BP ($r=0.56$, $p=0.001$) lends support to its use in vascular dysfunction and therefore towards platelet reactivity with hypertensive pathology. Equivalently, the dramatic increase in PDW ($p<0.001$) reflects increased heterogeneity of the platelets, a marker of increased turnover following endothelial stress. Its weak correlation with systolic BP ($r=0.46$, $p=0.013$) suggests that variation in platelets can precede disease severity and outcome. These findings are consistent with international reports highlighting the value of platelet indices as potential early markers of adverse outcomes in PE [11]. These measurements in present screening may allow for the early identification of high-risk patients, allowing intervention to be initiated earlier.

5. Conclusion

The importance of the tremendous changes in the platelet indices in preeclampsia and their potential use as disease severity surrogate markers on the basis of MPV and PDW is highlighted through this study. The high coefficient of correlation with systolic BP of MPV makes it an important clinical value in predicting the vascular dysfunction to come. The study highlights the potential of platelet indices to be used as a biomarker in in routine prognosis in the treatment of preeclampsia.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships influenced by this work.

Authors contribution

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Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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