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Original Article

UNLOCKING THE FUTURE OF MATERNAL HEALTH: PLATELET INDICES AS PREDICTORS OF PREECLAMPSIA

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ABSTRACT

Objective: Preeclampsia is a dangerous pregnancy condition that puts the health of the mother and fetus at great risk. Early diagnosis and treatment of this illness depend on predictive signs. Because of their correlation with coagulation problems, platelet indices, such as platelet count (PC), platelet distribution width (PDW), mean platelet volume (MPV), and platelet crit (PCT), may be useful as biomarkers for preeclampsia. The purpose of this study is to find out how well platelet indices can predict preeclampsia.

Methods: From Mar 1, 2021, to Feb 28, 2022, the study was carried out at the Kamla Nehru State Hospital for Mother and Child in Shimla, Himachal Pradesh. Pregnant women without pre-existing illnesses were removed, and those with normotension who had singleton pregnancies after 20 w of gestation were included. Patients were classified according to the degree and course of preeclampsia, and platelet indices were monitored during pregnancy. To ascertain the significance of fluctuations in the platelet index, statistical tests were conducted and data were analyzed using SPSS-PC-25.

Results: According to the study, patients with preeclampsia (PE) and normotensive individuals had significantly different platelet indices. Compared to people with normotension, PE patients showed higher platelet distribution width (PDW), a lower platelet count, and an elevated mean platelet volume (MPV). Interestingly, MPV increased noticeably in PE before blood pressure rose. In severe PE patients, the platelet count drastically reduced. The potential of MPV and platelet count as predictors of PE was shown by Receiver Operating Characteristic (ROC) curve analysis. These results demonstrate the importance of platelet indices in the diagnosis of PE and the potential use of these indices as early indicators of this hypertensive condition in pregnancy.

Conclusion: Platelet indices show potential as early indicators for identifying and tracking preeclampsia, especially platelet count, MPV, and PDW. Monitoring platelet indices in addition to blood pressure may help determine the extent and course of the illness, which might lead to better results for both the mother and the fetus. To improve clinical usefulness and improve prediction models, more research in this area is necessary.

Keywords: Preeclampsia, Platelet count, Mean platelet volume, Platelet distribution width, Plateletcrit, Predictive markers, Pregnancy complications, Maternal health, Fetal outcomes

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INTRODUCTION

About 5% of pregnancies become complicated due to preeclampsia, a challenging and occasionally deadly disease that seriously jeopardizes the health of the mother [1]. This disease raises the risk of perinatal death, early birth, and fetal growth limitation in addition to causing morbidity and mortality in the mother. Before 20 w of pregnancy or after giving birth, preeclampsia is characterized by the sudden onset of hypertension and proteinuria in previously normotensive women or by the onset of hypertension accompanied by significant end-organ failure. It is further classified into various groups based on its severity [2]. Elevated blood pressure, proteinuria, thrombocytopenia, renal insufficiency, reduced liver function, pulmonary edema, and neurological symptoms are examples of severe features.

Interestingly, 7% of patients who have preeclampsia in one pregnancy may experience it again in later pregnancies, which emphasizes the need of understanding its underlying mechanisms and predictive markers [3]. Improving maternal healthcare in India, where preeclampsia is estimated to affect 8–10% of pregnant women, requires addressing the issues related to the condition [4].

The pathogenesis of preeclampsia is complicated; however, one important contributing factor has been identified as abnormal placentation. The improper cytotrophoblast cell invasion of spiral arteries, which results in modifications to the coagulation and fibrinolysis processes, is a major factor in the pathogenesis of preeclampsia [5]. During a healthy pregnancy, trophoblastic invasion into myometrial blood vessels changes the mother's spiral arteries, which guarantees proper placental perfusion. If this process is not completed, high-resistance spiral arterioles persist, leading to malfunction of maternal endothelial cells and relative hypoxemia [6].

Soluble forms like tyrosine kinase-1 (sFlt-1) and soluble endoglin (sEng) are two examples of angiogenic markers that increase in response to placental hypoxia and ischemia [7]. These markers impact endothelial dysfunction in the mother vasculature, which results in a vasoconstrictive condition, oxidative stress, and microemboli that harm several organ systems. Endothelial damage stimulates the coagulation system, which raises platelet aggregation and causes hematologic anomalies, thrombocytopenia being the most common. The fact that differences in platelet indices exhibit potential as early diagnostic instruments and preeclampsia predictions is noteworthy [8].

Mean platelet volume (MPV), platelet count (PC), platelet distribution width (PDW), and plateletcrit (PCT) are among the parameters that make up platelet indices [9]. While MPV shows the average size of platelets, PDW shows the heterogeneity in platelet morphology brought on by the coexistence of larger platelets alongside normal-sized ones [10]. On the other hand, although being influenced by MPV and platelet count, PCT gives data on platelet activity and indicates the total platelet mass. Because a low PCT may suggest lower platelet activity in the blood, these measurements are helpful in detecting preeclampsia even before changes in traditional coagulation markers like prothrombin time (PT), activated partial thrombin time (aPTT), and thrombin time become evident.

In the sections that follow, we examine the significant relationship between platelet indices and the beginning of preeclampsia and

provide insight on their possible use as diagnostic markers for this condition. Through a prospective study, we want to ascertain the predictive utility of platelet indices in the early detection of preeclampsia, which would ultimately improve the outcomes for maternal healthcare [11, 12].

MATERIALS AND METHODS

Study type and location

This study, conducted at Kamla Nehru State Hospital for Mother and Child, Shimla took place from September 2021 to October 2022. It employed a cross-sectional design to assess proteinuria assessment methods in pregnant women with preeclampsia.

Selection criteria

Women between the ages of 18 and 40 who had a gestational age more than 20 w determined by either the starting day of the last menstrual cycle or first-trimester ultrasonography met the inclusion criteria. In order to be eligible, participants had to be diagnosed with blood pressure (BP) equal to or higher than 140/90 mmHg on at least two different occasions. BP had to be measured in a seated position using an appropriately sized cuff, with a minimum 4 h gap between measurements, and using Korotkoff phase V for diastolic blood pressure. Moreover, inclusion required the presence of proteinuria.

Those having a history of proteinuria and chronic hypertension before to conception or the onset of hypertension prior to 20 w of gestation were excluded. Individuals who needed to be delivered before the 24 h urine sample collection period was over, those with a history of recurrent UTIs, and those with established chronic renal illness were also not included.

Procedure

Participants provided informed consent, and their medical history was meticulously recorded, including symptoms of preeclampsia. Anthropometric data and comprehensive physical examinations were conducted. Pregnancy and hypertension tests were performed. Participants collected 24 h urine samples, and a single voided urine sample was obtained for the spot urinary protein/creatinine ratio.

Urine protein and creatinine levels were measured using spectrophotometry, and the ratio was calculated utilizing an automated spectrophotometry analyzer. This comprehensive approach ensured precise data collection for comparing proteinuria assessment methods.

Ethical approval

Ethical approval for this study was obtained from the appropriate institutional review board or ethics committee, ensuring that the research adhered to ethical guidelines and protected the rights and well-being of the study participants.

Statistical analysis

Statistical analysis was performed to evaluate the diagnostic accuracy of the spot urinary protein/creatinine ratio compared to the 24 h urine protein collection method. This analysis included sensitivity, specificity, predictive values, receiver operating characteristic (ROC) curve analysis, and correlation coefficients. Statistical software, such as SPSS, was used for these analyses to derive meaningful and reliable results.

RESULTS

The mean platelet volume (MPV) alterations in pre-eclamptic (PE) and normotensive pregnant individuals are compared in table 1. With a 26.8% change in PE without severe characteristics and a 57.5% change in PE with severe features, MPV increased considerably in PE and peaked between 32–36 and 36–40 w. This increase in MPV occurred four to six weeks before a major rise in blood pressure. On the other hand, MPV did not significantly rise in pregnant normotensive women. Every four weeks, the three groups were compared, and PE with severe symptoms had the highest MPV ($P<0.001$). PE without severe features and normotensive pregnant women came in second and third, respectively.

Platelet count alterations in normotensive pregnant women and pre-eclamptic (PE) individuals are compared in table 2. There was a notable drop in platelet counts in PE, with severe cases showing a loss of 37.1% between 32 and 36 w, and non-severe cases showing an increase of 18.2%. This decrease became more noticeable as the pregnancy progressed and happened prior to a noticeable increase in blood pressure. Normotensive individuals had consistently higher platelet counts, with a statistically significant difference ($P<0.001$) between the groups.

Platelet distribution width (PDW) alterations in normotensive pregnant individuals and pre-eclamptic (PE) patients are compared in table 3. PDW barely changed till 32 w in a typical pregnancy. Even prior to an increase in blood pressure, PDW values in PE patients were greater and strongly increased with the severity of hypertension. The PDW rise was largest for PE with severe characteristics (37.1%), followed by PE without severe features (29.3%) and those with normal blood pressure (20%). $P<0.001$ indicated that these differences were statistically significant.

Table 4 compares the variations in Plateletcrit between pregnant individuals with normotension and those with preeclampsia. The platelet crit in each of the three groups decreased every 4 w until 36–40 w, as this table illustrates. In individuals with normotension, the Plateletcrit dropped to around 16.7%, although the difference was negligible. In the PE group without severe features, plateletcrit also decreased to 18.2%. Comparatively, during 32–40 w of gestation, plateletcrit decreased dramatically in the PE with severe feature group, reaching about 20% with a significant P-value of 0.03.

Table 1: Comparison of changes in mean platelet volume (fl) between normotensive pregnant patients and preeclampsia patients

POG (weeks)	Normotensive	PE without severe feature	PE with severe feature	P value
≥20 to ≤24(a_1)	9.04±0.87	10.27±0.84	11.21±0.66	<0.001
≥24 to≤28(a2)	9.20±0.91	10.54±1.06	12.23±0.81	<0.001
≥28 to≤32(a3)	9.72±0.89	11.30±0.98	14.97±0.60	<0.001
≥32 to≤36(a4)	10.29±1.02	12.37±0.81	15.77±1.58	<0.001
≥36 to≤40(a5)	10.51±0.98	12.93±1.29	17.6±1.020	<0.001
% Change between a1 to a5	16.7%	26.8%	57.5%	

Table 2: Comparison of changes in platelet count (10^3/µl) normotensive pregnant patients and preeclampsia patients

POG (weeks)	Normotensive	PE without severe feature	PE with severe feature	P value
≥20 to ≤24(a_1)	248.10±62.25	217.17±63.71	184.38±48.95	<0.001
≥24 to ≤28(a2)	244.19±61.77	207.17±63.67	176.88±57.75	<0.001
≥28 to ≤32(a3)	240.14±60.70	199.17±59.64	175.63±30.32	<0.001
≥32 to ≤36(a4)	236.52±61.10	189.17±58.51	146.25±30.79	<0.001
≥36 to ≤40(a5)	235.33±61.13	181.17±62.82	124.13±22.72	<0.001
% Change between a1 to a5	6.1%	18.2%	37.1%	

Table 3: Comparison of changes in platelet distribution width (fl) between normotensive pregnant patients and preeclampsia patients

POG (weeks)	Normotensive	PE without severe feature	PE with severe feature	P value
≥20 to ≤24(a_1)	13.18±1.13	14.90±0.58	16.11±0.75	<0.001
≥24 to ≤28(a2)	13.47±0.97	15.07±0.60	17.02±0.69	<0.001
≥28 to ≤32(a3)	14.35±0.94	15.33±0.71	18.47±0.33	<0.001
≥32 to ≤36(a4)	15.52±1.16	16.3±1.07	19.9±1.11	<0.001
≥36 to ≤40(a5)	15.74±1.19	19.07±1.68	21.98±1.47	<0.001
% Change between a1 to a5	20%	29.3%	37.1%	

Table 4: Comparison of changes in plateletcrit (%) between normotensive pregnant patients and preeclampsia patients

POG (weeks)	Normotensive	PE without severe feature	PE with severe feature	P value
≥20 to ≤24(a_1)	0.24±0.04	0.22±0.10	0.21±0.14	0.05
≥24 to ≤28(a2)	0.23±0.04	0.21±0.05	0.19±0.05	0.10
≥28 to ≤32(a3)	0.22±0.04	0.20±0.05	0.18±0.04	0.04
≥32 to ≤36(a4)	0.21±0.04	0.19±0.05	0.18±0.05	0.03
≥36 to ≤40(a5)	0.20±0.04	0.18±0.06	0.17±0.05	0.03
% Change between a1 to a5	16.7%	18.2%	20%	

Table 5: Comparison of mean platelet volume, platelet count, PDW and Plateletcrit between normotensive pregnant patients and preeclampsia patients

Platelet indices	Normotensive	Preeclampsia	P value
MPV (fl)	9.04±0.87	10.51±0.89	<0.001
Platelet count (10^3/µl)	248.10±62.25	193.97±59.86	<0.001
PDW (fl)	13.18±1.13	15.2±0.81	<0.001
Plateletcrit (%)	0.24±0.04	0.22±0.11	<0.001

Table 5 shows substantial differences in many platelet parameters between normotensive people and preeclampsia patients. With a significant p-value<0.001, the mean platelet volume (MPV) was greater in preeclamptic patients (10.51±0.89 fl) than in normotensive individuals (9.04±0.87 fl). In addition, preeclamptic women had higher platelet distribution widths (PDW) (15.2±0.81 fl) than normotensive women (13.18±1.13 fl). With a significant p-value<0.001, the platelet count was lower in preeclampsia (193.97±59.86 x 10^3/µl) than in healthy pregnant females (248.10±62.25 x 10^3/µl). In a same vein, the preeclampsia group's Plateletcrit (0.22±0.11%) was considerably lower than that of the normal control group (0.24±0.04%).

Table 6: Correlation index between mean arterial blood pressure and platelet count, mean platelet volume and platelet distribution width in patients with preeclampsia

POG (weeks)	Platelet count (10^3/µl)		Mean platelet volume (fl)		Platelet distribution width(fl)	
	r value	p value	r value	p value	r value	p value
≥20 to ≤24(a_1)	-0.51	<0.001	+0.74	<0.001	+0.57	<0.001
≥24 to ≤28(a2)	-0.60	<0.001	+0.79	<0.001	+0.65	<0.001
≥28 to ≤32(a3)	-0.81	<0.001	+0.80	<0.001	+0.59	<0.001
≥32 to ≤36(a3)	-0.87	<0.001	+0.84	<0.001	+0.67	<0.001
≥36 to ≤40(a5)	-0.85	<0.001	+0.87	<0.001	+0.76	<0.001

Strong positive relationships between platelet indices and mean arterial blood pressure are seen in table 6. Peaking around 36–40 w of gestation, mean platelet volume (MPV) showed a substantial positive connection (r=+0.87, p<0.001) with rising blood pressure. Across all gestational ages, platelet distribution width likewise shown a strong positive connection, peaking at 36–40 w (r=+0.76, p<0.001). On the other hand, in the preeclampsia group, a negative association was noted between blood pressure and platelet count, which peaked at 32–36 w (r=-0.87, p<0.001).

DISCUSSION

Our study has demonstrated that the assessment of platelet indices in pregnant patients has offered relevant information regarding the dynamics of platelet-related abnormalities during gestation, specifically in the setting of normotensive pregnancies and those affected by preeclampsia (PE). Treating the symptoms of preeclampsia on both the mother and the fetus, as well as comprehending the pathophysiology of this complex multisystem condition, remain extremely challenging [13].

In our study, 270 pregnant women between the ages of 20 and 24 w gestation, singleton pregnancies, and normal blood pressure were included. These patients saw a doctor every four weeks until delivery, and regular blood pressure and complete blood counts (CBCs) were taken at each visit. The findings of our investigation shed light on a number of critical aspects of platelet dynamics in normotensive and pre-eclamptic pregnancies [14].

Among the noteworthy findings of the study is the incidence of preeclampsia, which was determined to be 13%, somewhat higher than the global standard of 5–10%. This discrepancy may be attributed to the fact that our hospital is a tertiary care referral center, where difficult and high-risk referrals may result in a higher number of preeclampsia cases being seen [15].

Our sample's average age at which preeclampsia manifested itself was 29.81 5.65 y, which aligns with results from earlier investigations conducted under similar conditions. This research highlights the effect of later marriages delaying pregnancies, which raises the risk of hypertensive problems during pregnancy in women between the ages of 25 and 29 [16].

Preeclampsia was found to be more common in primigravida women than in multigravida women, accounting for 59.4% of cases in the former group and 40.6% in the latter. This is in line with past research that indicates primigravida women have a higher risk of preeclampsia. Crucially, we looked at platelet indicators such as platelet count, platelet distribution width (PDW), mean platelet volume (MPV), and platelet crit during various gestational stages. We observed a substantial difference in these platelet indices between normotensive and pre-eclamptic patients [17].

Platelet count decreased significantly with gestational age, with severe preeclampsia patients exhibiting the greatest fall. This decrease in platelet count indicated thrombocytopenia, a common and early preeclampsia consequence linked to endothelial damage and coagulation system activation. Moreover, we found a negative correlation between mean arterial pressure (MAP) and platelet count in pre-eclamptic patients [18]. Monitoring blood pressure and platelet count together may provide a predictive method for assessing the degree and course of preeclampsia. The unfavorable correlation was greater with increasing gestational age, especially between weeks 32 and 36 [19].

We also examined MPV, which increased markedly with gestational age in pre-eclamptic patients compared to normotensive individuals. This surge was more pronounced in severe preeclampsia patients, which may have been caused by enhanced platelet synthesis or the discharge of larger platelets as a result of thrombocytopenia [20]. Platelet heterogeneity was demonstrated to rise with increasing gestational age, similar to PDW, particularly in cases of severe preeclampsia. Since PDW is a marker for platelet activation, it might highlight the active turnover of platelet production in this instance as a reaction to peripheral platelet consumption [21].

Mean arterial pressure and MPV or PDW showed favorable relationships in preeclampsia patients, suggesting that these indices might be helpful in forecasting the onset and severity of hypertension during pregnancy. In conclusion, our research evaluated the diagnostic utility of various platelet indices in the anticipation of pregnancy-related hypertension diseases. A PDW of ≥14.15 fl, an MPV of ≥10.1 fl, and a platelet count of ≤184×10^3/µl were shown to be related with an increased risk of developing hypertensive disorders during pregnancy [22].

CONCLUSION

In summary, our work has shown the potential of platelet indices as useful markers and surveillance instruments for preeclampsia, a dangerous and sometimes fatal pregnancy-related condition. Between normotensive and pre-eclamptic individuals, we found substantial changes in platelet indices, such as mean platelet volume (MPV), platelet count, and platelet distribution width (PDW). The fact that these variations frequently occurred before clinically substantial blood pressure increase highlights their potential use as early indicators of preeclampsia.

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Nil

AUTHORS CONTRIBUTIONS

All authors have contributed equally.

CONFLICT OF INTERESTS

Declared none

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