Original Article

Platelet Indices and Their Role in Gestational Diabetes Mellitus and Pre-Eclampsia: A Comparative Study

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Abstract

Background: Gestational diabetes mellitus (GDM) and pre-eclampsia (PE) are common pregnancy complications linked to significant maternal and perinatal morbidity. Both conditions involve platelet activation and systemic inflammation, making platelet indices potential markers for early diagnosis and monitoring.
Methods: This comparative study involved 180 pregnant women divided equally into three groups: newly diagnosed PE, newly diagnosed GDM, and healthy controls. Participants were recruited at LNJP Hospital, New Delhi. Platelet indices including platelet count, mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit, platelet large cell ratio (P-LCR), platelet-lymphocyte ratio (PLR), and neutrophil-lymphocyte ratio (NLR) were measured using a hematology analyzer. Statistical analysis was conducted using one-way ANOVA with post-hoc Tukey test to compare groups.
Result: Significant alterations in platelet indices were observed in both GDM and PE groups compared to controls ($p < 0.001$). MPV, PDW, P-LCR, PLR, and NLR levels were elevated in GDM and PE, with the highest values in PE. Platelet count and plateletcrit were notably reduced, especially in PE. These findings indicate enhanced platelet activation and systemic inflammation in these conditions.
Conclusion: Platelet indices demonstrate significant changes in GDM and PE, reflecting their role in the pathogenesis of these disorders. Given their accessibility through routine blood tests, these indices offer cost-effective, non-invasive tools for early risk assessment and monitoring. Further large-scale studies are recommended to validate their clinical utility.

Keywords: diabetes, gestational; pre-eclampsia; platelet count; platelet activation; neutrophil-lymphocyte ratio

Introduction

Gestational diabetes mellitus (GDM) and pre-eclampsia (PE) are among the most clinically significant complications of pregnancy, contributing substantially to maternal and perinatal morbidity and mortality worldwide.[1] GDM is defined as glucose intolerance with onset or first recognition during pregnancy and represents the most common metabolic disorder encountered in obstetric practice.[2] It is associated with adverse outcomes including polyhydramnios, macrosomia, neonatal hypoglycemia, intrauterine growth restriction (IUGR), congenital malformations, and increased risk of type 2 diabetes mellitus in the mother later in life.[3]

PE, on the other hand, is a pregnancy-specific multisystem disorder characterized by hypertension and proteinuria or end-organ dysfunction after 20 weeks of gestation. It remains a leading cause of maternal morbidity, accounting for

significant rates of maternal mortality, fetal demise, and iatrogenic preterm birth.[4] Despite extensive research, its exact pathogenesis remains elusive. Abnormal placentation, systemic endothelial dysfunction, exaggerated inflammatory response, and hypercoagulability are considered central to its development.[5]

Platelets, as key cellular mediators of hemostasis and inflammation, play an important role in both disorders. During pregnancy, progressive hemodilution and uteroplacental circulation remodeling influence platelet count and function. Platelet indices, which include platelet count, mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit, and platelet large cell ratio (P-LCR), provide insights into platelet activation status.[6] Larger platelets, reflected by higher MPV, are metabolically more active, release greater amounts of thromboxane A_2, and have increased pro-thrombotic potential.[7] Similarly, PDW reflects variation in platelet size and is another marker of platelet activation.

In GDM, chronic low-grade inflammation, mediated by interleukins and leukocytes, is thought to contribute to insulin resistance and endothelial dysfunction. In PE, placental ischemia and release of vasoactive substances promote platelet activation, aggregation, and consumption, leading to thrombocytopenia in severe cases.[8] These shared mechanisms suggest that platelet indices may be useful in the early identification and monitoring of these conditions.

Several studies have demonstrated alterations in platelet indices in GDM and PE. Sahbaz et al. reported significantly lower platelet count and plateletcrit in GDM, though MPV differences were not significant.[9] Conversely, Yilmaz et al. found significantly elevated MPV in GDM compared with controls.[10] In PE, Thalor et al. showed higher MPV and PDW with insignificant platelet count differences,[11] whereas Sitotaw et al. found platelet count, MPV, and PDW all significantly altered.[12] Recent meta-analyses also support the association of inflammatory ratios such as platelet-lymphocyte ratio (PLR) and neutrophil-lymphocyte ratio (NLR) with GDM and PE.[13, 14]

Despite these findings, most studies are limited by small sample sizes, inconsistent results, or lack of direct comparison between GDM and PE cohorts. Therefore, we designed the present study to comprehensively evaluate platelet indices in both GDM and PE, directly comparing them with healthy pregnant women, to better define their diagnostic and prognostic utility. While previous studies have examined platelet indices in isolation, this study provides a direct, head-to-head comparison between GDM and PE cohorts using identical laboratory protocols. This allows for a unique differentiation of the magnitude of platelet activation and inflammatory response between metabolic (GDM) and hypertensive (PE) pregnancy disorders.

Diagnostic and exclusion criteria

GDM: Diagnosed using the 75g Oral Glucose Tolerance Test (OGTT) as per IADPSG/ADA guidelines (fasting $\geq$ 92 mg/dL, 1-hr $\geq$180 mg/dL, or 2-hr $\geq$153 mg/dL). PE: Defined as new-onset hypertension (SBP $\geq$140 mmHg or DBP $\geq$90 mmHg) after 20 weeks of gestation with proteinuria ($\geq$300 mg/24h or 1+ dipstick) or end-organ dysfunction. Exclusion Criteria: Patients with pre-existing chronic hypertension, pre-gestational diabetes (Type 1 or 2), chronic kidney disease, autoimmune disorders (e.g., SLE), or active infections were excluded to prevent confounding of inflammatory markers.

Materials and Methods

The present study aimed to evaluate and compare platelet indices among three groups of pregnant females—those with newly diagnosed pre-eclampsia (PE), those with newly diagnosed gestational diabetes mellitus (GDM), and healthy pregnant controls in order to explore their potential clinical significance. The study population comprised of pregnant females admitted to the Department of Obstetrics and Gynecology at LNJP Hospital, New Delhi, and the work was be conducted in the Department of Clinical Pathology of the same institution. Pregnant women with newly diagnosed GDM, confirmed by oral glucose tolerance test (OGTT), or with newly diagnosed PE, and having a singleton live fetus, were included in the study. Exclusion criteria consisted of co-morbid conditions, multiple gestations, intrauterine fetal death or growth restriction, history of adverse obstetric outcomes, current or past use of anticoagulants, and prior history of PE or GDM.

Based on sample size calculation, 60 patients were recruited in each case group (PE and GDM) and their results were compared with 60 healthy controls, yielding a total of 180 participants. Venous blood samples were collected under aseptic precautions and analyzed using the Mindray BC-6200 hematology analyzer in the Clinical Pathology Laboratory, and the obtained hematological parameters were statistically compared across the three groups.

Statistical analysis

Data were analyzed using SPSS version 21. Descriptive statistics were expressed as mean $\pm$ standard deviation (SD) for continuous variables. Normality was assessed using Kolmogorov–Smirnov test. Comparisons among groups were performed using one-way ANOVA with post-hoc Tukey test for normally distributed variables. Chi-square test was used for categorical data. A p-value $<$0.05 was considered statistically significant.

Ethical considerations

The protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of LNJP Hospital/Maulana Azad Medical College. Informed written consent was obtained from all participants prior to recruitment.

Results

Baseline characteristics

The mean maternal age was similar across groups (Control: 27.8 ± 3.9 years; GDM: 28.2 ± 4.1; PE: 27.5 ± 4.2, p = 0.61). Gestational age at recruitment did not differ significantly (Control: 29.4 ± 2.6 weeks; GDM: 29.1 ± 2.8; PE: 28.9 ± 3.0, p = 0.47). BMI was higher in the GDM group compared to controls and PE ($p < 0.05$).

Hematological indices

Table 1 summarizes platelet indices across groups. Significant differences were observed for all indices ($p < 0.001$).

Table 1: Platelet indices in control, GDM, and PE groups.

Parameter	Control (n=60)	GDM (n=60)	PE (n=60)	p-value
Platelet count ($\times 10^9$/L)	243.8 ± 36.3	229.8 ± 42.5	204.6 ± 49.8	<0.001
Plateletcrit	0.222 ± 0.041	0.199 ± 0.052	0.182 ± 0.046	<0.001
MPV (fL)	9.10 ± 0.79	9.80 ± 1.02	9.93 ± 0.90	<0.001
PDW (%)	12.00 ± 1.44	13.36 ± 1.79	13.85 ± 1.80	<0.001
P-LCR (%)	22.0 ± 5.1	26.5 ± 5.3	30.2 ± 6.6	<0.001
PLR	111.9 ± 18.6	132.4 ± 24.8	142.0 ± 30.9	<0.001
NLR	2.14 ± 0.48	2.47 ± 0.68	3.02 ± 0.71	<0.001

Discussion

Our study demonstrated significant alterations in platelet indices in both GDM and PE compared to healthy controls. MPV, PDW, P-LCR, PLR, and NLR were consistently elevated in GDM and PE, whereas platelet count and plateletcrit were significantly lower, particularly in PE. These findings reinforce the role of platelet activation and systemic inflammation in the pathogenesis of both conditions.

The reduction in platelet count in PE observed in our study is consistent with the endothelial dysfunction model, wherein platelet activation and consumption contribute to thrombocytopenia.[11, 12] Our values (204.6 ± 49.8 $\times 10^9$/L) are comparable to those reported by Sitotaw et al. in Ethiopian women (202 $\times 10^9$/L in PE vs. 245 $\times 10^9$/L in controls).[12]

In GDM, although platelet count was lower than controls, the reduction was less pronounced, suggesting predominant platelet activation without substantial consumption. This agrees with Sahbaz et al., who found significantly lower platelet counts in GDM but within the normal physiological range.[9]

MPV and PDW were significantly higher in both GDM and PE, reflecting increased platelet turnover. Our results parallel those of Yilmaz et al., who found MPV 9.69 ± 1.32 in GDM vs. 8.81 ± 1.1 in controls.[10] Similarly, Thalor et al. reported higher MPV and PDW in PE ($p < 0.05$).[11] Elevated MPV has been linked with increased thromboxane A_2 release, explaining the pro-thrombotic tendency in both disorders.[7]

P-LCR, a measure of large circulating platelets, was highest in PE, further supporting exaggerated platelet activation. This agrees with a recent meta-analysis by Hessami et al., showing elevated PLR and P-LCR in GDM and PE.[13]

Inflammatory ratios such as PLR and NLR showed strong discriminatory power in our study. Both were significantly higher in GDM and PE, with the highest values in PE. Similar findings were reported by Huang et al., who demonstrated that first-trimester NLR and PLR could predict subsequent development of GDM.[14] Salama et al. also found significant correlations of these ratios with severity of PE.[15]

Clinical actionability

The study identifies specific trends that could guide management. For instance, an MPV > 9.5 fL and NLR > 2.5 in the early third trimester may serve as "red flags" for clinicians to increase the frequency of prenatal visits or Doppler surveillance.

Unlike expensive biomarkers like sFlt-1/PlGF, these indices are available in real-time from a standard Complete Blood Count (CBC), allowing for immediate risk stratification in resource-limited settings.

Limitations

Single-Center Design: The study was conducted at a single tertiary center in New Delhi, which may limit the generalizability of the absolute values to different ethnic populations. BMI Confounder: While BMI was significantly higher in the GDM group ($p < 0.05$), it is a known physiological characteristic of the condition. Future studies should employ multivariate regression or BMI-matched controls to independently isolate the effect of obesity from metabolic platelet activation. Study Design: The cross-sectional nature at the time of diagnosis prevents the determination of whether these changes precede the clinical onset of disease.

Conclusion

Platelet indices including MPV, PDW, P-LCR, PLR, and NLR are significantly altered in women with GDM and PE compared to healthy pregnancies. These indices reflect underlying platelet activation and systemic inflammation, processes central to the pathophysiology of both disorders. Given their availability from routine complete blood count, they represent cost-effective, non-invasive adjuncts for risk stratification and early prediction. Further multicentric prospective studies are warranted to validate their prognostic value and integrate them into clinical practice.

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Competing Interests: None

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