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Research Article

VARIATION IN PLATELET INDICES IN HYPERTENSIVE DISORDERS OF PREGNANCY: A CROSS-SECTIONAL STUDY FROM A TERTIARY CARE HOSPITAL IN NORTH BENGAL

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Abstract

Background: Hypertensive disorders of pregnancy (HDP) are considered one of the leading causes of maternal and perinatal morbidity and mortality worldwide. Platelet indices such as platelet count (PC), mean platelet volume (MPV), platelet distribution width (PDW), and platelet-large cell ratio (P-LCR) have been proposed as simple hematological markers for early identification of disease severity. This study aimed to evaluate variations in platelet indices across different forms of HDP and compare them with uncomplicated pregnancies.

Methods: This hospital-based cross-sectional study was conducted among 250 third-trimester pregnant women attending a tertiary hospital in North Bengal. Participants were categorized into uncomplicated pregnancies, chronic hypertension, gestational hypertension, pre-eclampsia, and eclampsia groups. Blood samples were analyzed using automated hematology analyzer (SYSMEX XS-800i, Japan). Data were analyzed using SPSS version 22, and a p-value < 0.05 was considered statistically significant.

Results: The mean PC, MPV, PDW, and P-LCR were $3.41 \pm 0.72 \times 10^5/\mu L$, 10.45 ± 3.73 fl, 14.32 ± 6.11 fl, and $21.79 \pm 7.81\%$, respectively. PC was significantly lower ($p < 0.001$), while MPV, PDW, and P-LCR were significantly higher in hypertensive pregnancies compared to uncomplicated cases. Post-hoc Bonferroni analysis revealed progressive reductions in PC and increases in MPV, PDW, and P-LCR with increasing

disease severity, particularly in pre-eclampsia and eclampsia.

Conclusion : Platelet indices, especially PC, MPV, and PDW, vary significantly in women with HDP, reflecting increased platelet activation and consumption. These parameters may serve as reliable, cost-effective adjunctive markers for early detection and severity assessment of HDP in resource-limited settings.

Keywords: Eclampsia; Hypertensive disorders of pregnancy; Mean platelet volume; Platelet count; Platelet distribution width; Platelet indices; Platelet-Large cell ratio; Pre-eclampsia

INTRODUCTION

Hypertensive disorders in pregnancy (HDP) comprises one of the most common complications of pregnancy encountered in the general obstetric practice, and, coupled with hemorrhage and infections, they make up one-third of the triad of conditions that are responsible for the vast majority of maternal deaths worldwide [1]. It has been estimated that hypertensive disorders complicate 5-10% of all pregnancies, with pre-eclampsia alone causing the death of 50-60,000 mothers per year globally [2].

Hypertensive disorders in pregnancy exist in a spectrum, and vary depending on their time of onset, mode of presentation, and severity [2]. The most widely accepted classification of hypertensive disorders of pregnancy divides these cases into five major groups, viz. gestational hypertension, pre-eclampsia, eclampsia, pre-eclampsia superimposed on chronic hypertension, and chronic hypertension complicating pregnancies [3]. In India, hypertensive disorders of pregnancy affect approximately 5.2% of pregnancies, while preeclampsia has been reported in 2–10% of pregnancies, with variations across different regions and healthcare settings [4]. The exact pathophysiology of hypertensive disorders in pregnancy is still debated. Research on the topic suggests that these are complex, multi-organ, and multisystem diseases with a gamut of risk factors and causative mechanisms [5].

Platelet indices, which include platelet count (PC), mean platelet volume (MPV), platelet distribution width (PDW), and platelet large cell ratio (PLCR) have emerged as important biomarkers showing promise in the prediction of HDP, especially in pre-eclampsia [2,6]. It is hypothesized that alterations in coagulation, fibrinolysis, platelet morphology, platelet count and vascular endothelial function play a key role in its' pathogenesis [7].

India too, being a developing country, faces a substantial burden of hypertensive disorders complicating pregnancies nationwide. Therefore, identifying an easy-to-perform, economical, and widely available and acceptable biomarker assay in the prediction of these conditions is the need of the hour. Henceforth, this study aims to assess and compare the platelet indices between healthy pregnant women and pregnant women with hypertensive disorders.

MATERIALS AND METHODS

This observational cross-sectional study was conducted jointly in the Departments of Physiology and Obstetrics and Gynecology. The study population comprised of pregnant women in their third trimester of pregnancy presenting to the outpatient department (OPD) of the Department of Obstetrics and Gynecology. Eligible participants were recruited consecutively after screening according to the predefined inclusion and exclusion criteria.

Prior approval for the study was obtained from the Institutional Ethics Committee before commencement of data collection. Written informed consent was obtained from all participants after explaining the nature, objectives, and procedures of the study in their local language. Confidentiality of participants was maintained throughout the study. A detailed obstetric, medical, family, and medication history was obtained from each participant, followed by a general physical and obstetric examination.

The diagnosis and categorization of hypertensive disorders of pregnancy were established through review of medical records, clinical examination findings, and standardized blood pressure measurements. Classification of hypertensive disorders of pregnancy has evolved over time. The participants were categorized according to the ACOG guidelines which includes five major groups: gestational hypertension, pre-eclampsia, eclampsia, chronic hypertension, and pre-eclampsia superimposed on chronic hypertension [3]. Operational definitions of each category have been provided in the supplementary material.

Participants were excluded if they had any condition likely to influence platelet count or platelet indices independently of hypertensive status. Exclusion criteria included known coagulation disorders, congenital disorders, autoimmune diseases, thyroid dysfunction, chronic kidney disease, diabetes mellitus, hepatic disease, or any other significant systemic illness. Women receiving antiplatelet agents (such as aspirin or clopidogrel), anticoagulants, or medications associated with bone marrow suppression were also excluded. Additional exclusions included history of alcohol consumption, any form of tobacco use, and receipt of blood transfusion within the preceding two weeks.

For hematological analysis, 2 mL of venous blood was collected aseptically from the antecubital vein of each participant using a sterile auto-disposable syringe and transferred immediately into an EDTA (dipotassium ethylenediamine tetraacetic acid) anticoagulant vial. Samples were transported to the Department of Hematology and processed within two hours of collection in order to minimize pre-analytical variability and preserve platelet morphology. Complete blood count analysis, with particular emphasis on platelet parameters including platelet count (PC), mean platelet volume (MPV), platelet distribution width (PDW), and platelet large cell ratio (PLCR), was performed using an automated hematology analyzer (Sysmex XS-800i, Sysmex Corporation, Japan). Routine internal quality control procedures and participation in external quality assurance programs were maintained

throughout the study period to ensure analytical reliability and accuracy.

All collected data were reviewed for completeness, consistency, and accuracy before entry into a predesigned Microsoft Excel database (Microsoft Excel 2017, Microsoft Corporation, USA). Statistical analysis was performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 22.0, IBM Corp., Armonk, NY, USA). Data were summarized using appropriate descriptive statistics. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation (SD). Comparison of continuous variables across multiple study groups was performed using one-way analysis of variance (ANOVA). When the ANOVA test demonstrated statistical significance, pairwise group comparisons were carried out using Bonferroni post-hoc correction to control for multiple testing. A two-tailed p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 250 participants were finally included in the study population. The mean age of the participants was 25.6 ± 3.9 years. Baseline demographic and clinical characteristics of the study population are summarized in **Table 1**.

Parameters	**Frequency**	**Percentage**
Age group (years)		
18-24	101	40.4
25-29	104	41.6
>30	45	18
Blood Pressure		
BP	Mean	SD
SBP	136.4	19.3
DBP	84.9	13.1
Hemoglobin		
Hb (gm%)	Mean	SD
	10.64	1.72
Final diagnosis		
Uncomplicated pregnancy	153	61.2

Chronic hypertension	17	6.8
Gestational hypertension	48	19.2
Pre-eclampsia	21	8.4
Eclampsia	11	4.4
Pre-eclampsia superimposed on chronic hypertension	0	0

Table 1: Baseline characteristics of the study population

Most participants belonged to the 25–29 years age group (41.6%). The mean systolic blood pressure of the participants was 136.4 ± 19.3 mmHg, while the mean diastolic blood pressure was 84.9 ± 13.1 mmHg. Regarding final diagnosis, uncomplicated pregnancy constituted the largest group (61.2%), followed by gestational hypertension (19.2%). Only 4.4% of study population suffered from eclampsia

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Comparison of hematological and platelet parameters among different types of hypertensive disorders of pregnancy (HDP) is presented in **Table 2**.

HDP Type	Mean Hb (gm/dl)	p-value	Mean PC ($\times 10^5/\mu L$)	p-value	Mean MPV (fL)	p-value	Mean PDW	p-value	Mean P-LCR	p-value
Uncomplicated pregnancy	10.59 ± 1.1	<0.001*	3.69 ± 0.46	<0.001*	9.54 ± 0.22	<0.001*	13.96 ± 0.53	0.007*	18.09 ± 0.24	<0.001*
Chronic hypertension	9.82 ± 2.49	-	3.10 ± 0.21	—	12.67 ± 1.02	—	14.01 ± 1.24	—	26.68 ± 1.44	
Gestational hypertension	11.06 ± 2.24	-	2.96 ± 0.09	—	11.28 ± 0.79	—	13.24 ± 0.68	—	28.81 ± 0.85	
Pre-eclampsia	10.21 ± 2.41	-	2.85 ± 0.14	—	12.46 ± 0.76	—	18.71 ± 1.22	—	31.15 ± 1.56	
Eclampsia	11.50 ± 2.76	-	2.19 ± 0.16	—	12.38 ± 0.49	—	19.18 ± 1.56	—	31.28 ± 1.69	
Total Study poulation	10.64 ± 1.72		3.41 ± 0.72		10.45± 3.73		14.32± 6.11		21.79 ±7.81	

Table 2: Comparison of Platelet Parameters among Different Types of Hypertensive Disorders of Pregnancy (HDP)

Table note: Values are expressed as mean ± standard deviation. F-values were calculated using one-way ANOVA. (***P < 0.01** indicating a highly significant difference between groups)

A statistically highly significant difference was observed between uncomplicated pregnancies and pregnancies complicated by HDP with respect to mean PC, mean MPV, mean PDW, and mean P-LCR.

Post-hoc Bonferroni-adjusted pairwise comparisons are presented in **Table 3**.

Parameter	Group Comparison	Mean Difference	Adjusted p-value
PC ($\times 10^5/\mu L$)	Uncomplicated pregnancy vs Chronic hypertension	0.59	0.002
	Uncomplicated pregnancy vs Gestational hypertension	0.73	<0.001
	Uncomplicated pregnancy vs Pre-eclampsia	0.84	<0.001
	Uncomplicated pregnancy vs Eclampsia	1.5	0.001
	Chronic hypertension vs Eclampsia	0.91	0.005
MPV (fl)	Uncomplicated pregnancy vs Chronic hypertension	-3.13	0.007
	Uncomplicated pregnancy vs Gestational hypertension	-1.74	0.032
	Uncomplicated pregnancy vs Pre-eclampsia	-2.92	0.005
	Uncomplicated pregnancy vs Eclampsia	-2.84	0.01
	Chronic hypertension vs Eclampsia	0.29	0.041
PDW	Uncomplicated pregnancy vs Pre-eclampsia	-4.75	0.008
	Uncomplicated pregnancy vs Eclampsia	-5.22	0.001

	Gestational hypertension vs Pre-eclampsia	-5.47	0.006
	Gestational hypertension vs Eclampsia	-5.94	0.004
P-LCR	Uncomplicated pregnancy vs Chronic hypertension	-8.59	<0.001
	Uncomplicated pregnancy vs Gestational hypertension	-10.72	<0.001
	Uncomplicated pregnancy vs Pre-eclampsia	-13.06	<0.001
	Uncomplicated pregnancy vs Eclampsia	-13.19	<0.001

Table 3: Bonferroni Post-hoc Pairwise Comparison of Platelet Parameters Among Study Groups

Table note: Only statistically significant pairwise Bonferroni-adjusted comparisons are shown. Negative mean differences indicate lower values in the first-mentioned group compared with the second-mentioned group.

Women with uncomplicated pregnancies demonstrated significantly higher platelet counts compared with those with chronic hypertension, gestational hypertension, pre-eclampsia, and eclampsia. Mean MPV was significantly lower in uncomplicated pregnancies compared with all hypertensive groups. Similarly, PDW and P-LCR were significantly increased in women with hypertensive disorders of pregnancy, particularly in pre-eclampsia and eclampsia.

DISCUSSION

HDP is a leading cause of maternal and perinatal illness and deaths around the world, accounting for about 10% of all pregnancies [8]. Early identification of women at risk and timely intervention are therefore essential to improve maternal and fetal outcomes. In recent years, platelet indices derived from routine hematological investigations have gained attention as potential biomarkers reflecting the vascular and inflammatory changes associated with HDP.

The mean age of most participants ranged between 25 and 29 years,(Table 1) indicating a significant clustering of hypertensive disorders within this particular age group. The findings were consistent with Annam et al., Abass et al., and Manchanda et al [9-11]. The relatively narrow age range accentuates the importance of focusing preventive health strategies and clinical interventions on this age group to mitigate the risks associated with hypertensive disorders during pregnancy [12]. Such data is imperative for formulating targeted healthcare policies and enhancing the clinical management of pregnant women, potentially improving

maternal and fetal outcomes in the Indian context.

The mean hemoglobin level of the study population (10.64 gm%, Table 1) is slightly lower than the expected normal range for pregnancy, indicating that a considerable proportion of the study population may have been mildly anaemic. Reduced hemoglobin levels can impair oxygen-carrying capacity, potentially triggering compensatory cardiovascular responses that may influence the development of hypertensive disorders during pregnancy [13]. This observation highlights the importance of routine hematological screening, appropriate nutritional interventions and blood pressure regulation during antenatal care to optimize maternal health [14]

A key finding was the statistically significant difference between uncomplicated pregnancies and those complicated by HDP across all platelet indices. (Table 2) Platelet count was significantly lower in hypertensive pregnancies, while MPV, PDW, and P-LCR were significantly elevated. These findings suggest increased platelet activation and consumption in hypertensive disorders of pregnancy. Endothelial dysfunction, a hallmark of conditions such as pre-eclampsia and eclampsia, promotes platelet aggregation and activation, resulting in accelerated platelet turnover and subsequent alterations in platelet morphology and indices.

The present study demonstrated a progressive decline in PC with increasing severity of hypertensive disorders. Women with eclampsia showed the lowest platelet counts compared with other groups. This finding supports the concept that platelet consumption increases as the disease progresses. Similar associations between reduced platelet count and hypertensive disorders of pregnancy have been reported by Annam et al., Vijaya et al., Doğan et al., and Gogoi et al., reinforcing the role of platelet depletion in the pathophysiology of these conditions [11, 13-15*]*. Post-hoc Bonferroni pairwise analysis further showed that women with uncomplicated pregnancies had significantly higher platelet counts than those with HDP, with the greatest reduction observed in eclampsia. A significant difference was also noted between chronic hypertension and eclampsia, highlighting the progressive fall in platelet count with worsening disease severity.

MPV was observed to be significantly higher in hypertensive pregnancies compared with uncomplicated pregnancies. Larger platelets are known to be metabolically and enzymatically more active, possessing greater prothrombotic potential. The increase in MPV observed in HDP may therefore reflect enhanced platelet activation and accelerated platelet turnover secondary to endothelial injury. Studies conducted by Abass et al., AlSheeha et al., and Zhang et al., have demonstrated significant alterations in MPV in women with pre-eclampsia compared with normotensive pregnancies, supporting the role of platelet activation in the pathogenesis of hypertensive disorders of pregnancy [11,16,17]. Smilarly Temur et al. and Bawore et al., identified MPV as a potential predictor of pre-eclampsia [18.19]. These observations support the hypothesis that MPV could serve as a useful hematological

marker for identifying women at increased risk of hypertensive complications during pregnancy. Bonferroni-adjusted comparisons in the present study also demonstrated significantly lower MPV values in uncomplicated pregnancies compared with chronic hypertension, gestational hypertension, pre-eclampsia, and eclampsia, supporting an increase in platelet activation across disease categories.A significant difference was also noted between chronic hypertension and eclampsia.

PDW, which indicates the variation in platelet size, was also found to be significantly raised in women with HDP, especially those with pre-eclampsia and eclampsia. PDW is being increasingly recognized for its potential role in identifying and monitoring the progression of pregnancy-associated hypertensive conditions such as gestational hypertension, pre-eclampsia, and eclampsia [20]. Increased PDW indicates heterogeneity in platelet size, often associated with enhanced platelet activation and increased platelet turnover. Such alterations are consistent with the thrombo-inflammatory state characteristic of hypertensive disorders of pregnancy. Previous studies by Dhakre et al., Thalor et al., Manchanda et al., and Bawore et al. have similarly reported significant associations between elevated PDW and HDP, further supporting the diagnostic and prognostic value of this parameter [10,19,21,22]. Pairwise analysis revealed significant differences between uncomplicated pregnancy and pre-eclampsia, uncomplicated pregnancy and eclampsia, as well as between gestational hypertension and both pre-eclampsia and eclampsia, suggesting that PDW rises further with increasing clinical severity.

Similarly, P-LCR was significantly higher in hypertensive pregnancies compared with uncomplicated pregnancies. P-LCR represents the proportion of large platelets in circulation and serves as an indicator of platelet activation and increased platelet production. Elevated P-LCR suggests the presence of larger, more reactive platelets, which may contribute to the prothrombotic state observed in hypertensive pregnancy disorders [11]. Post-hoc analysis demonstrated significantly lower P-LCR values in uncomplicated pregnancies compared with all hypertensive groups, with the greatest differences seen in pre-eclampsia and eclampsia. Although significant differences were observed between uncomplicated and hypertensive pregnancies, no significant variation in P-LCR was noted among the different HDP subgroups, suggesting that while P-LCR may reflect the presence of platelet activation, it may be less useful in differentiating between specific hypertensive conditions.

Overall, the results obtained in this study support the growing evidence that the use of platelet parameters obtained through routine blood tests may serve as useful adjunctive markers in the diagnosis of hypertension-related pregnancy disorders. Given that they are inexpensive and easily available, these markers can be incorporated in routine antenatal testing to aid in the early identification of high-risk pregnancies, particularly in resource-limited settings.

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CONCLUSION

Our study revealed a high prevalence of hypertensive disorders of pregnancy in this region and demonstrated significant alterations in platelet indices among affected women compared with those with uncomplicated pregnancies. PC showed a declining trend with increasing disease severity, while MPV, PDW, and P-LCR were significantly elevated, reflecting increased platelet activation and turnover. The study reiterates the usefulness of platelet indices such as PC, MPV, PDW and P-LCR as biomarkers of hypertensive disorders of pregnancy and the potential utility of platelet indices as simple, cost-effective markers for early identification and monitoring of hypertensive disorders of pregnancy.

LIMITATIONS

The study was not without limitations. As a cross-sectional study, it could not account for obstetric history or practices prior to arrival at the hospital, potentially introducing confounding effects on platelet indices. Future longitudinal studies following women from conception to delivery may offer clearer insights.

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