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A Comparative Study of Immature Platelet Fraction, Mean Platelet Volume and Aspartate Aminotransferase to Platelet Ratio Index Score in Pre-eclampsia and Normotensive Pregnant Women

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Abstract

Background: Hypertensive disorders during pregnancy, particularly preeclampsia, remain a leading cause of maternal and fetal morbidity and mortality worldwide. Despite advances in diagnostic modalities, simple and cost-effective markers for early detection and severity assessment are needed. This study aimed to evaluate the clinical utility of Immature Platelet Fraction (IPF), Mean Platelet Volume (MPV), and Aspartate Aminotransferase to Platelet Ratio Index (APRI) as potential biomarkers in preeclampsia.

Methods: A prospective, observational comparative study was conducted on 320 pregnant women (160 preeclamptic and 160 normotensive controls) at SMS Medical College, Jaipur. Hematological parameters including IPF, MPV, and APRI were assessed at two time points: at recruitment and prior to delivery. Data were analyzed using SPSS v29.0, with a p-value <0.05 considered statistically significant.

Results: IPF, MPV, and APRI levels were significantly higher in the preeclampsia group compared to normotensive controls at both assessment points (p<0.05). While intragroup differences over time were

not statistically significant, these parameters consistently remained elevated in preeclamptic women. Further, severe preeclampsia cases demonstrated significantly higher IPF (12.59 ± 2.91 vs. 11.02 ± 2.42; p=0.02), MPV (8.09 ± 0.167 vs. 7.83 ± 0.11; p=0.01), and APRI (2.9 ± 1.81 vs. 2.13 ± 1.77; p=0.04) compared to mild cases. In patients with HELLP syndrome, MPV was notably elevated, with a non-significant rising trend in IPF.

Conclusion: IPF, MPV, and APRI are significantly associated with the presence and severity of preeclampsia and may serve as reliable, cost-effective supplementary markers for its early detection and risk stratification. Their inclusion in routine antenatal evaluations could enhance clinical decision-making and improve maternal-fetal outcomes.

Keywords: Preeclampsia, Immature Platelet Fraction, Mean Platelet Volume, APRI, Biomarkers, Pregnancy, HELLP syndrome

Introduction

Hypertensive disorders during pregnancy are a significant cause of maternal and fetal morbidity and mortality worldwide, with pre-eclampsia complicating approximately 2% of all pregnancies.[1] Over the past two decades, its incidence has risen by nearly 25%, emphasizing the urgent need for better strategies in early detection and management.[2] Pre-eclampsia is characterized by new-onset hypertension (≥140/90 mmHg) and proteinuria (≥300 mg/24 hours) after 20 weeks of gestation[3] and is subclassified as early-onset (before 34 weeks) or late-onset (at or after 34 weeks). Common clinical manifestations include headache, visual disturbances, and upper abdominal pain.[4] The severe form, HELLP syndrome—marked by haemolysis, elevated liver enzymes, and low platelet counts—is diagnosed using either the Mississippi or Tennessee criteria.[5]

Although proteinuria and hypertension are shared features of both pre-eclampsia and HELLP syndrome, the latter is distinctly associated with pronounced thrombocytopenia and haemolysis. Despite advancements in screening tools, the precise mechanisms influencing platelet production and turnover in these conditions remain poorly understood. Current predictive approaches, such as Doppler ultrasonography and angiogenic markers like soluble fms-like tyrosine kinase 1 (sFlt-1) and placental growth factor (PlGF), have improved early diagnosis. Elevated sFlt-1/PlGF ratios—greater than 85 before 34 weeks and over 110 after 34 weeks—are indicative of high risk.[6,7] However, these tests are costly, technically demanding, and not yet widely available in all clinical settings.[8]

Haematological parameters such **as** Immature Platelet Fraction (IPF)**,** Mean Platelet Volume (MPV)**,** and the Aspartate Aminotransferase to Platelet Ratio Index (APRI) are emerging as simple, cost-effective, and accessible biomarkers with potential utility in pre-eclampsia evaluation. IPF reflects bone marrow response to increased platelet consumption and typically remains below 10% in healthy pregnancies.[9,10] MPV serves as an indicator of platelet activation and size, with elevated values correlating with heightened platelet reactivity and endothelial dysfunction in pre-eclampsia.[11] APRI, originally used to assess liver fibrosis, also provides insight into hepatic stress and thrombocytopenia associated with severe pre-eclampsia.[12]

The present study aims to evaluate and compare IPF, MPV, and APRI scores in normotensive versus pre-eclamptic pregnancies**,** assessing their potential as

reliable, non-invasive markers for the early detection, severity assessment, and monitoring of pre-eclampsia.

Materials and Methods

This prospective, observational, comparative study was conducted in the Department of Obstetrics and Gynaecology, SMS Medical College, Jaipur, over one year. Pregnant women aged 20 to 40 years, with a gestational age between 20 and 40 weeks, who provided informed consent and were not part of any other clinical study, were included. Women with known platelet disorders (ITP, TTP), aplastic anemia, those on anticoagulant therapy, or with liver disease, ischemic heart disease, collagen vascular disorders, or autoimmune diseases were excluded. A total of 160 participants were enrolled in each group. Group I comprised preeclamptic women diagnosed according to ACOG guidelines, while Group II included gestational age-matched normotensive controls. Hematological parameters—immature platelet fraction (IPF), mean platelet volume (MPV), and APRI score—were assessed twice in all participants: at diagnosis or recruitment and again before labor induction or cesarean delivery. IPF was measured using an automated hematology analyzer, MPV was derived from complete blood counts, and APRI was calculated from AST levels and platelet counts. Data were analyzed using SPSS version 29.0. Continuous variables were expressed as mean ± SD and compared using the unpaired Student's *t*-test. Categorical data were presented as frequencies and percentages and analyzed with the Chi-square or Fisher's exact test as appropriate. A *p*-value <0.05 was considered statistically significant.

Results

Demographic characteristics

In our study comprising 160 patients, the demographic and clinical profiles of both groups were comparable. The majority of women in both Group A (58.12%) and Group B (57.5%) belonged to the 26–30 years age group, with mean ages of 27.57 ± 3.0 years and 27.71 ± 2.93 years, respectively ($p>0.05$). Most participants were non-working, accounting for 69.37% in Group A and 62.5% in Group B ($p>0.05$). Socioeconomic assessment revealed that 91.2% of Group A and 80.6% of Group B fell under the upper-lower and lower socioeconomic classes ($p>0.05$). Regarding religion, 66.25% of Group A were Muslim, while 33.75% were Hindu ($p=0.23$). Rural residence was reported by 57.5% of Group A and 58.75% of Group B ($p>0.05$). Illiteracy rates were high in both groups (56.87% in Group A vs. 56.2% in Group B), with very few attaining higher education (0.6% in each group; $p>0.05$). Multigravida women predominated in both groups (80% in Group A, 85% in Group B; $p>0.05$). Mean gestational age was 27.24 ± 4.8 weeks, with the highest proportion (31.25%) between 25–29 weeks. A history of preeclampsia was significantly more common in Group A (8.75%; $p<0.05$). The mean systolic and diastolic blood pressures in Group A were 149.45 ± 4.8 mmHg and 95.0 ± 3 mmHg, respectively, with 85.62% classified as having mild and 14.37% as severe preeclampsia.

Comparison of Haematological and Biochemical Parameters between Group A and Group B

Immature Platelet Fraction (IPF%) was significantly elevated in preeclamptic women (Group A) compared to normotensive controls (Group B) at both recruitment (12.31 ± 3.33 vs. 7.88 ± 3.5; $p<0.05$) and admission

(12.4 ± 2.74 vs. 7.90 ± 3.5; p<0.05). However, the intra-group differences between these two time points were not statistically significant (p>0.05). Similar findings were reported by Everett et al. (2014),[13] who demonstrated a significantly higher IPF% in preeclamptic women (3.8%; 9.6/nl) compared to normotensive pregnant women (0.9%; 3.4/nl) with a p-value of 0.01, suggesting increased platelet turnover in preeclampsia. Moraes et al.[14] (2016) also observed significantly higher IPF% in preeclamptic women (mean 8.6%) than in normotensive controls (3.8%). Notably, the IPF% range in our study was broader than in these reports. Additionally, Bernstein et al.[15] (2019) reported varying IPF% levels across different pregnancy complications, with the highest median IPF% in women with HELLP syndrome (10.4%), followed by those with preeclampsia (7.6%), and the lowest in healthy normotensive women (4.1%), supporting the association of elevated IPF% with hypertensive disorders of pregnancy.

We find Mean Platelet Volume (MPV) was significantly higher in the preeclampsia group compared to controls at both recruitment (8.47 ± 0.82 vs. 6.89 ± 0.16; p<0.05) and admission (8.49 ± 0.87 vs. 6.09 ± 0.16; p<0.05). However, no significant change was noted within the groups over time (p>0.05). These findings align with Bellos et al.[11] (2018), who reported a significantly elevated MPV in preeclamptic women, with a mean difference of 1.04 fL (95% CI: 0.76–1.32), particularly in severe cases. Pickel et al.[10] (2018) also identified MPV as a predictive marker for preeclampsia, suggesting a cut-off value of 10.85 fL. Similarly, Tariq et al.[16] (2021) observed significantly higher MPV in preeclamptic women (10.98 ± 1.55 fL) compared to normotensive controls (9.79 ± 1.59 fL; p<0.001).

Liver enzymes, particularly ALT, were significantly elevated in the preeclamptic group (84.5 ± 33.9 U/L at recruitment; 84.9 ± 33.7 U/L at admission) compared to controls (34.5 ± 10.6 U/L and 34.1 ± 10.5 U/L; p<0.05), with no significant change over time. Similar findings were reported by Bellos et al., Munazza et al., Iqbal et al., and Tariq et al., all showing higher ALT levels in preeclamptic women, indicating hepatic involvement in the disease.[11,12,16]

AST levels were significantly higher in the preeclampsia group at both recruitment and admission (94.1 ± 13.6 U/L and 94.8 ± 13.4 U/L) compared to controls (35.4 ± 8.2 U/L and 36.1 ± 13.2 U/L; p<0.05), with no significant intragroup change. Similar elevations were noted in studies by Bellos et al., Munazza et al., Iqbal et al., and Tariq et al., highlighting AST as a marker of hepatic dysfunction in preeclampsia.[11,12,17]

The APRI score was significantly higher in the preeclamptic group at both recruitment (2.69 ± 1.81) and admission (2.60 ± 1.81) compared to controls (0.18 ± 0.047 and 0.22 ± 0.05; p<0.05), with no significant variation within groups over time (p>0.05). Bellos I et al.[11] 2018 found that APRI scores above 2.5 were predictive of severe preeclampsia, with higher scores correlating with increased maternal complications such as hepatic impairment and thrombocytopenia. Pickel K et al.[10] 2018 identified an APRI cut-off of 2.65 as a marker of severe preeclampsia, with a sensitivity of 75% and specificity of 38% for predicting maternal complication. Iqbal et al.[17] 2019 reported similar findings, with preeclamptic women having a significantly higher APRI score (3.47 ± 1.7) compared to normotensive pregnant women (0.16 ± 0.05).

Table 1: Comparison of Haematological and Biochemical Parameters Between Group A and Group B

Parameter	Time Point	Group A (Mean ± SD)	Group B (Mean ± SD)	P-value (Between Groups)	P-value (Within Group)
IPF (%)	At Recruitment	12.31 ± 3.33	7.88 ± 3.5	<0.05	>0.05
	At Admission	12.4 ± 2.74	7.90 ± 3.5	<0.05	
MPV (fL)	At Recruitment	8.47 ± 0.82	6.89 ± 0.16	<0.05	>0.05
	At Admission	8.49 ± 0.87	6.09 ± 0.16	<0.05	
ALT (U/L)	At Recruitment	84.5 ± 33.9	34.5 ± 10.6	<0.05	>0.05
	At Admission	84.9 ± 33.7	34.1 ± 10.5	<0.05	
AST (U/L)	At Recruitment	94.1 ± 13.6	35.4 ± 8.2	<0.05	>0.05
	At Admission	94.8 ± 13.4	36.1 ± 13.2	<0.05	
APRI Score	At Recruitment	2.69 ± 1.81	0.18 ± 0.047	<0.05	>0.05
	At Admission	2.60 ± 1.81	0.22 ± 0.05	<0.05	

Comparison of IPF%, MPV and APRI between Mild and Severe Preeclampsia

In this study, IPF, MPV, and APRI were significantly higher in severe preeclampsia compared to mild cases. IPF was 12.59 ± 2.91 in severe vs. 11.02 ± 2.42 in mild cases (p=0.02), MPV was 8.09 ± 0.167 vs. 7.83 ± 0.11 (p=0.01), and APRI was 2.9 ± 1.81 vs. 2.13 ± 1.77 (p=0.04), indicating greater platelet activation and hepatic dysfunction with disease severity. These findings align with Cakir B et al. [18] and Vanli T et al.,[19] who also reported elevated MPV and APRI in severe preeclampsia.

Conclusion

Our study concludes that IPF, MPV, and APRI levels are significantly higher in preeclamptic women compared to normotensive controls, indicating their potential utility as early biomarkers for the detection of preeclampsia. Moreover, these markers were found to increase progressively with the severity of preeclampsia, showing statistically significant differences between mild and severe cases. In patients with HELLP syndrome, MPV was notably elevated, while IPF showed a non-significant rising trend, reflecting heightened platelet turnover and activation. These findings emphasize the clinical importance of IPF, MPV, and APRI as additional tools for the evaluation and risk stratification of preeclampsia, especially in identifying severe disease. Incorporating these parameters into routine antenatal screening could improve early diagnosis, risk assessment, and ultimately maternal and fetal outcomes.

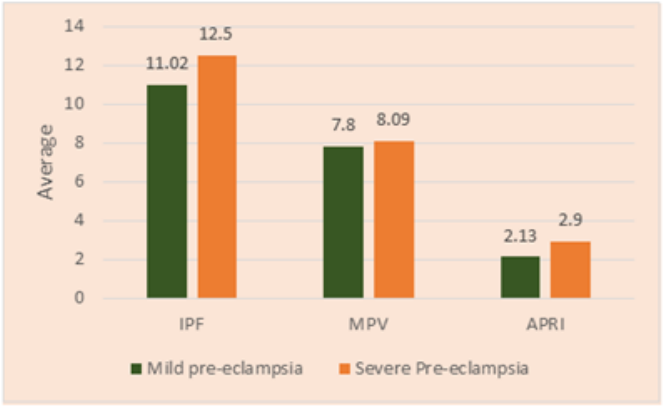

Figure 1: Comparison of IPF%, MPV and APRI between Mild and Severe Preeclampsia

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