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Association of Mean Platelet Volume with the Risk of Preterm Premature Rupture of Membranes

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Abstract

Background: Preterm Premature Rupture of Membranes (PPROM) is a significant obstetric complication associated with adverse maternal and neonatal outcomes. Identifying early hematological markers could aid in risk prediction and preventive strategies. This study investigates the association between Mean Platelet Volume (MPV) and Platelet Count (PC) measured at 11–13 weeks of gestation with the risk of PPROM. ***Methods:*** This prospective cohort study was conducted at the Department of Fetomaternal Medicine and Obstetrics and Gynecology, Bangabandhu Sheikh Mujib Medical University (BSMMU), from September 2022 to August 2023 included 73 pregnant women who underwent MPV and PC measurement at 11–13 weeks of gestation. Participants were monitored until delivery for PPROM occurrence. Diagnostic efficacy was assessed using Receiver Operating Characteristic (ROC) curve analysis, and risk estimation was performed using relative risk (RR) calculations. ***Results:*** PPROM occurred in 9 out of 73 participants (12.3%). A significantly lower MPV (≤8.0 fL) was observed in 77.8% of PPROM cases compared to 6.3% in the non-PPROM group ($p<0.001$), with a relative risk (RR) of 19.73. The combination of high PC (≥294,000/cu.mm) and low MPV (≤8.0 fL) was present in 44.4% of PPROM cases versus 4.7% in the non-PPROM group ($p=0.003$), with an RR of 7.54. ROC analysis showed that MPV had an AUC of 0.856, with 77.8% sensitivity, 93.8% specificity, 98.9% positive predictive value (PPV), and 37.2% negative predictive value (NPV), indicating a stronger predictive value than PC. ***Conclusion:*** MPV measured at 11–13 weeks of gestation is a strong predictor of PPROM, with better diagnostic accuracy than PC. The combination of low MPV and high PC further strengthens this association. Early screening using MPV may help identify high-risk pregnancies, allowing for closer monitoring and timely interventions.

Keywords: Mean Platelet Volume, Platelet Count, Preterm Premature Rupture of Membranes, Early Pregnancy, Risk Prediction, Hematological Markers.

INTRODUCTION

Preterm premature rupture of membranes (PPROM) is an obstetric condition that occurs when the premature rupture of membranes happens prior to 37 weeks of gestation, with a high risk of preterm delivery, neonatal morbidity, and maternal complications [1]. PPROM predisposes to a range of perinatal

complications including respiratory distress syndrome, neonatal sepsis, intraventricular hemorrhage, and long-term neurodevelopmental impairment [2]. In addition, maternal complications like chorioamnionitis, endometritis, and postpartum infections are increased after PPROM. Even though it has a clinical importance, the precise pathogenesis of PPROM is still multifactorial and complex with multiple biological, environmental, as well as genetic factors being involved in its development [3]. Hence, the discovery of valid predictive markers for PPROM should be a priority to achieve early risk stratification and appropriate obstetric interventions. Platelet indices, including platelet count (PC) and mean platelet volume (MPV), are being explored as potential biomarkers for the prediction of various obstetric complications [4].

MPV is a marker of the average size of circulating platelets and reflects platelet activation, function, and turnover. MPV has been studied in relation to numerous medical conditions, including cardiovascular diseases, inflammatory disorders, and pregnancy-related complications like preeclampsia, gestational diabetes, and intrauterine growth restriction [5]. Platelet function and activation during pregnancy have been found to occur adequately as the pregnant body adjusts the hematologic composition to sustain growth of the fetus and maintain hemostasis. Because platelets are involved in inflammation and clotting reactions, MPV would be an appropriate marker to foretell complications arising during pregnancy such as PPROM. Some studies suggest that decreased MPV can be correlated with adverse outcomes of pregnancy, possibly due to augmented platelet consumption and turnover in response to the underlying inflammatory mechanisms [6]. Inflammatory mediators also play an important role in the weakening of the fetal membranes such that they rupture prematurely.

PPROM has been associated with subclinical intra-amniotic infection and excess inflammatory responses, which may be accountable for the alteration in platelet indices. Keeping this in view, MPV has emerged as a potential marker for risk of PPROM [7]. However, the specific relationship of MPV values in early pregnancy with risk for developing PPROM is not adequately studied, particularly in populations with varied demographic and clinical backgrounds. The ability to screen pregnant women at higher risk for PPROM using simple, low-cost, and readily available hematological markers such as MPV may have significant clinical relevance [8, 9]. Early detection of risk pregnancies would allow monitoring more intensively, applying preventive strategies, and timely intervention in order to avoid adverse perinatal outcomes [10]. During clinical practice, blood screening via CBC is already a part of standard antenatal care.

Adding MPV screening to standard tests would be helpful for making maternal health and pregnancy prognosis decisions without additional cost or invasive procedures [11]. While MPV has the potential to serve as a predictive biomarker for PPROM, very few data are documented about its diagnostic accuracy and cut-off values in diverse populations [12]. The majority of the studies have reported conflicting results for the association between MPV and pregnancy complications, and more research should be conducted to establish its clinical utility. The interaction between MPV and other hematological parameters, such as platelet count, should also be studied to determine if comprehensive evaluation would enhance predictive capability [3, 13]. This study aimed to evaluate the correlation between pregnancy MPV levels at 11–13 weeks and the risk of later PPROM development. By evaluating the platelet index of pregnant women and tracking the outcome of pregnancies, we will validate whether MPV can serve as an early indicator for PPROM. If the meaningful correlation is determined, MPV determination would be incorporated into antenatal care programs to determine high-risk pregnancy and improve mother-fetus outcome.

METHODOLOGY & MATERIALS

This prospective cohort study was conducted at the Department of Fetomaternal Medicine and Obstetrics and Gynecology, Bangabandhu Sheikh Mujib Medical University (BSMMU), from September 2022 to August 2023. A total of 73 pregnant women at 11–13 weeks of gestation attending the outpatient department who met the inclusion criteria were enrolled. Pregnant women at 11–13 weeks of gestation who were attending the outpatient department of Fetomaternal Medicine and Obstetrics and Gynecology and met the following criteria were included in the study: they had a confirmed gestational age of 11–13 weeks and had no diagnosed platelet disorders. Pregnant women with diagnosed platelet disorders, fetal anomalies, chronic hypertension, cardiac, renal, or liver disease, epilepsy, a history of PPROM, cervical incompetence, uterine anomalies, or threatened abortion were excluded. Patients were selected purposively, and data were collected through structured questionnaires, interviews, clinical examinations, and investigations. After obtaining informed consent, a 3 mL blood sample was collected from the antecubital vein to measure platelet count (PC) and mean platelet volume (MPV). Subjects were monitored through regular antenatal checkups until delivery to assess the occurrence of PPROM. PC within 150,000–450,000/cu mm and MPV between 7.2–9.2 fL were considered normal. Patients with high PC and low MPV were categorized as exposed, while those with normal values were non-exposed. Ethical approval was obtained from the Institutional Review Board, ensuring patient confidentiality and the right to withdraw at any stage. Statistical analysis was performed using SPSS version 22, and results were presented as tables and figures. Categorical variables were analyzed using the chi-square test and Fisher's exact test, with a p-value <0.05 considered statistically significant.

RESULTS

Table I: Demographic characteristics of the study subjects with non-exposed and exposed group

Characteristics	Non-exposed group	Exposed group	p-value
	Normal PC & Normal MPV (n=66)	High PC & Low MPV (n=7)	
Age (years)			
≤20	4 (6.1)	0 (0.0)	
21–25	41 (62.1)	1 (14.3)	
26–30	20 (30.3)	3 (42.9)	
31–35	1 (1.5)	1 (14.3)	
>35	0 (0.0)	2 (28.6)	
Mean ± SD	26.83 ± 4.81	30.18 ± 6.22	0.046
Min–max	18–38	21–41	
BMI (kg/m2)			
<18.5	1 (1.5)	1 (14.3)	0.320
18.5–24.9	62 (93.9)	6 (85.7)	
>24.9	3 (4.5)	0 (0.0)	
Parity			
Primi	26 (39.4)	3 (42.9)	0.509
Multipara	40 (60.6)	4 (57.1)	

Table I presents the demographic characteristics of the study subjects, categorized into two groups: the non-exposed group (normal platelet count and normal mean platelet volume) and the exposed group (high platelet count and low mean platelet volume). The mean age of the non-exposed group was 26.83 ± 4.81 years, while the exposed group had a higher mean age of 30.18 ± 6.22 years (p=0.046). No significant differences were observed in BMI (p=0.320) or parity (p=0.509) between the groups.

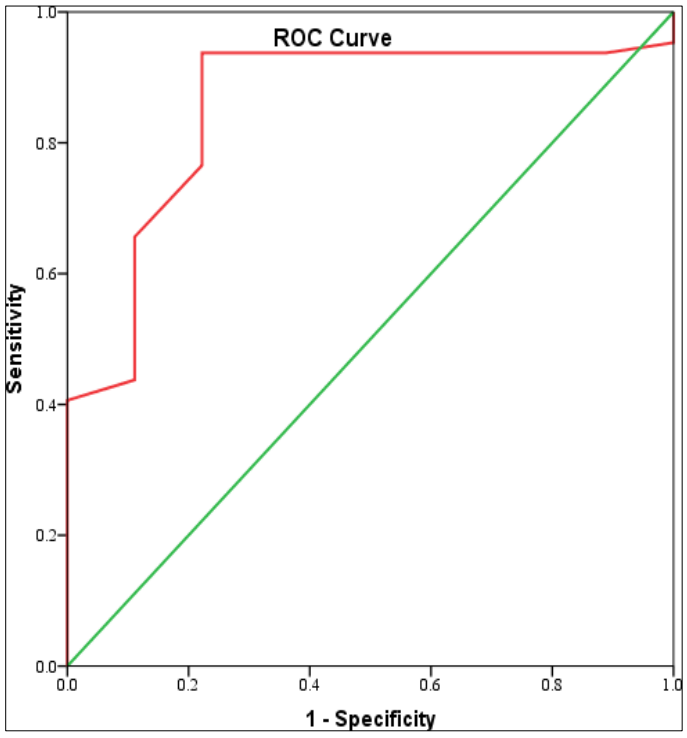

Figure 1: Mean platelet value (MPV) receiver operating characteristic (ROC) curve for the prediction of PPROM.

By choosing test value points that offered the highest sum of sensitivity and specificity, the ideal cut-off level was established (Fig. 1). With a sensitivity of 77.8%, specificity of 93.8%, PPV of 98.9%, and NPV of 37.2%, the ideal cut-off levels for MPV are less than 8 fL. At 95% CI 0.730 to 0.982, the ROC curve's area under the curve was 0.856.

Table II: Diagnostic efficacy parameters for the use of Mean Platelet Volume (MPV) in predicting PPROM for different cut-off point (n=73)

MPV	Sensitivity	Specificity	PPV	NPV	Youden Index
6.90	0.222	0.938	0.962	0.145	0.160
7.30	0.556	0.938	0.984	0.229	0.493
7.70	0.667	0.938	0.987	0.283	0.604
8.00	0.778	0.938	0.989	0.372	0.715
8.35	0.778	0.922	0.986	0.368	0.700
8.65	0.778	0.906	0.983	0.364	0.684
8.75	0.778	0.891	0.981	0.360	0.668

Table II presents the diagnostic efficacy of mean platelet volume (MPV) in predicting preterm premature rupture of membranes (PPROM) at different cutoff values. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and Youden's index were analyzed. The highest Youden's index (0.715) was observed at an MPV cutoff of 8.00, with a sensitivity of 77.8% and specificity of 93.8%, indicating this threshold as the optimal balance between sensitivity and specificity for predicting PPROM.

Table III: Mean platelet volume (MPV) in Study participants (n=73) with PPROM and non PPROM

MPV (At 11 to 13 weeks)	PPROM (n=9)	Non PPROM (n=64)	Total	RR	p-value
≤8.0	7 (77.8)	4 (6.3)	11 (15.1)	19.73	<0.001
>8.0	2 (22.2)	60 (93.7)	62 (84.9)		

Table III demonstrates the association between mean platelet volume (MPV) at 11–13 weeks of gestation and the risk of preterm premature rupture of membranes (PPROM). A significantly higher proportion of PPROM cases (77.8%) had MPV ≤8.0 fL, compared to only 6.3% in the non-PPROM group. Conversely, most non-PPROM cases (93.7%) had MPV >8.0 fL, while only 22.2% of PPROM cases fell into this category. The relative risk (RR) of developing PPROM with MPV ≤8.0 fL was 19.73, with a statistically significant p-value (<0.001), suggesting that lower MPV in early pregnancy is a strong predictor of PPROM risk.

Table IV: Platelet high and MPV low in PPROM Study participants (n=73)

Plt ≥ 294000 and MPV ≤ 8.0 (At 11 to 13 weeks)	PPROM (n=9)	Non PPROM (n=64)	Total	RR	p-value
Yes	4 (44.4)	3 (4.7)	7 (9.6)	7.54	0.003
No	5 (55.6)	61 (95.3)	66 (90.4)		

Table IV presents the association between a high platelet count (≥294,000) and low mean platelet volume (MPV ≤8.0 fL) at 11–13 weeks of gestation with the risk of preterm premature rupture of membranes (PPROM). Among PPROM cases, 44.4% had both high platelet count and low MPV, compared to only 4.7% in the non-PPROM group. Conversely, the majority of non-PPROM cases (95.3%) did not meet both criteria. The relative risk (RR) of developing PPROM in the presence of both high platelet count and low MPV was 7.54, with a statistically significant p-value (0.003). These findings suggest that the combination of these two hematological parameters in early pregnancy is strongly associated with an increased risk of PPROM.

DISCUSSION

This prospective cohort study aimed to evaluate the association between Mean Platelet Volume (MPV) and the risk of Preterm Premature Rupture of Membranes (PPROM) by measuring platelet parameters at 11–13 weeks of gestation and tracking pregnancy outcomes until delivery. A total of 73 pregnant women were included in the final analysis, with 9 (12.3%) developing PPROM. The sociodemographic characteristics of the participants showed that age, parity, and BMI did not significantly differ between the PPROM and non-PPROM groups. Most participants were aged 21–25 years (37.0%), had a normal BMI (94.5%), and were primiparous (39.72%). These findings are consistent with those of Kumari *et al.*, (2020), who reported similar demographic distributions among PPROM and non-PPROM groups [14].

The Receiver Operating Characteristic (ROC) curve analysis demonstrated that MPV had a high diagnostic performance, with an AUC of 0.856 (95% CI: 0.730–0.982). The optimal cutoff value for MPV was identified as ≤8.0 fL, which yielded a sensitivity of 77.8%, specificity of 93.8%, positive predictive value (PPV) of 98.9%, and negative predictive value (NPV) of 37.2%. These findings indicate that a lower MPV (≤8.0 fL) is significantly associated with an increased risk of PPROM, with a relative risk (RR) of 19.73. This aligns with Safaa *et al.*, who identified an MPV cutoff of ≤7.9 fL with a sensitivity of 69% and specificity of 58%,

though their diagnostic accuracy was lower than in our study [15].

The combined effect of MPV and Platelet Count was also evaluated to determine whether this combination could further enhance the predictive value for PPROM. The study found that only 3 patients (4.7%) in the non-PPROM group exhibited both a high Platelet Count (≥294,000/cu.mm) and a low MPV (≤8.0 fL), whereas 4 patients (44.4%) in the PPROM group had both characteristics. This combination was significantly associated with PPROM (p = 0.003) and had a relative risk of 7.54, indicating that women with both high platelet counts and low MPV at 11–13 weeks of gestation have a substantially increased risk of developing PPROM.

When comparing these findings to previous research, it is evident that MPV is a more reliable predictor of PPROM than Platelet Count alone. Ekin *et al.*, similarly reported that MPV had a higher predictive value for PPROM, with an AUC of 0.894 and a cutoff of <8.6 fL, yielding a sensitivity of 58%, specificity of 62%, PPV of 56%, and NPV of 64% [6]. Our study demonstrated higher sensitivity (77.8%) and specificity (93.8%), suggesting that MPV could be an effective early screening tool for identifying women at risk for PPROM. The discrepancy in cutoff values across studies could be attributed to differences in sample sizes, study populations, and laboratory techniques used for measuring platelet parameters.

Clinically, our findings emphasize the importance of assessing MPV in early pregnancy as a potential biomarker for PPROM risk stratification. Given its high specificity (93.8%) and PPV (98.9%), a low MPV (≤8.0 fL) could serve as a valuable screening tool for identifying high-risk pregnancies. Furthermore, the combination of low MPV and high Platelet Count may enhance risk prediction and assist obstetricians in implementing preventive strategies for PPROM, such as closer monitoring, lifestyle modifications, and early interventions [16, 17, 18].

Limitations of the study

Despite these significant findings, our study has some limitations. The relatively small sample size (n=73) may limit the generalizability of the results. Additionally, we did not include other inflammatory markers, such as C-reactive protein (CRP) or white blood cell count (WBC), which could have provided further insight into the underlying pathophysiology of PPROM. Future multicenter studies with larger cohorts are needed to confirm these findings and establish a standardized MPV cutoff value for predicting PPROM risk.

CONCLUSION

This study demonstrates that Mean Platelet Volume (MPV) and Platelet Count (PC) measured at 11–13 weeks of gestation are significantly associated with the risk of Preterm Premature Rupture of Membranes (PPROM). A low MPV was found to be a strong predictor of PPROM, showing superior diagnostic accuracy compared to PC. Furthermore, the combination of low MPV and high PC was significantly associated with an increased risk of PPROM, highlighting its potential as an early screening tool. These findings suggest that MPV measurement in early pregnancy could aid in identifying women at higher risk for PPROM, allowing for closer monitoring and timely interventions to improve maternal and fetal outcomes. Future research with larger, multicenter studies is needed to further validate these findings and explore their clinical applicability in obstetric care.

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