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Diagnostic Validity of Maternal Platelet Indices in Utero-Placental Insufficiency

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Abstract

Background: Utero-placental insufficiency (UPI) is a major cause of adverse pregnancy outcomes, including fetal growth restriction (FGR), preterm birth, and perinatal mortality. While Doppler ultrasonography remains the gold standard for diagnosing UPI, there is increasing interest in the role of maternal platelet indices as potential biomarkers for early detection. This study evaluates the diagnostic validity of maternal platelet indices—Total Platelet Count (TPC), Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), and Plateletcrit (PCT)—in detecting UPI.

Material & Methods: This is a prospective observational study was conducted at IMS & SUM Hospital, Bhubaneswar, over 25 months (December 2022–January 2025). A total of 851 antenatal women were included based on defined inclusion criteria. Maternal platelet indices were measured in the first trimester (8–12 weeks gestation) and correlated with Doppler findings of the uterine artery (UtA), umbilical artery (UA), and middle cerebral artery (MCA) at >22 weeks gestation. UPI was diagnosed based on abnormal Doppler parameters. Statistical analysis, including chi-square tests and logistic regression, was performed to determine the association and predictive value of platelet indices.

Results: Among the study participants, 8.2% had abnormal UtA PI, 7.2% had high UA PI, and 13.6% had low MCA PI, indicative of UPI. Abnormal platelet indices were significantly associated with UPI ($\chi^2=15.23$, $p<0.001$). The sensitivity, specificity, and diagnostic accuracy of platelet indices for detecting UPI were 42.4%, 73.3%, and 67.6%, respectively. MPV and PDW were the most predictive indices, showing significant correlation with abnormal Doppler parameters ($p<0.001$). Adverse pregnancy outcomes such as preterm birth ($\chi^2=8.75$, $p=0.003$) and fetal growth restriction ($\chi^2=35.2$, $p<0.001$) were significantly higher in women with abnormal platelet indices.

Conclusion: Maternal platelet indices, particularly MPV and PDW, show potential as early screening markers for UPI. While they cannot replace Doppler ultrasonography, they may serve as cost-effective, non-invasive adjuncts in resource-limited settings. Further large-scale studies are required to validate their clinical utility.

Introduction

Utero-placental insufficiency (UPI) is a critical obstetric condition characterized by inadequate blood flow to the placenta, leading to fetal hypoxia, growth restriction, and adverse perinatal outcomes. It is associated with hypertensive disorders, pre-eclampsia, and maternal vascular malperfusion, contributing to increased rates of preterm birth and stillbirth.

Doppler ultrasonography remains the gold standard for diagnosing UPI by assessing resistance in the uteroplacental and fetoplacental circulation. However, in resource-limited settings, access to Doppler technology may be restricted. There is growing interest in identifying alternative biomarkers that can serve as early screening tools.

Platelets play a crucial role in hemostasis and endothelial function. Changes in platelet indices such as Total Platelet Count (TPC), Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), and Plateletcrit (PCT) have been observed in pregnancy complications involving vascular dysfunction, including pre-eclampsia and FGR. However, their diagnostic utility in UPI remains underexplored.

This study aims to evaluate the association between maternal platelet indices and UPI, assess their predictive accuracy, and determine their potential role as non-invasive screening markers.

Methodology: This is a prospective observational study conducted at IMS & SUM Hospital, Bhubaneswar, over 25 months (December 2022–January 2025). Antenatal women attending the outpatient and inpatient departments were screened. A total of 851 women meeting the inclusion criteria were enrolled.

Inclusion Criteria:

- Singleton pregnancies
- Normotensive women without pre-existing comorbidities
- First-trimester presentation (<12 weeks gestation)

Exclusion Criteria:

- Spontaneous pregnancy loss before viability (<22 weeks)
- Multifetal pregnancies
- Chronic hypertension, diabetes, or hematological disorders
- Incomplete follow-up

Data Collection:

For the purpose of our study, Platelet Indices were taken as normal for screening for UPI if all of the following were normal-

- TPC = 1.5-4 x 10^5 / mm^3
- MPV = 8-11 fL

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- PDW = 9-17 fL
- PCT = 0.1-0.3 %

and abnormal for screening for UPI of any of the following was abnormal-

- TPC < 1.5 x 10^5 / mm^3
- MPV > 11 fL
- PDW > 17 fL
- PCT > 0.3 %

In our study, Utero-Placental Insufficiency was diagnosed when for that gestational age-

Mean Uterine Artery PI	in 2nd to 3rd Trimester (22-40 weeks POG)	>95th centile
Umbilical Artery PI	in 3rd Trimester (28-40 weeks POG)	>95th centile
Middle Cerebral Artery PI	in 3rd Trimester (28-40 weeks POG)	<5th centile

Statitical Analysis: Categorical variables were analyzed using chi-square tests. Logistic regression was performed to assess the predictive strength of platelet indices for UPI. Sensitivity, specificity, and diagnostic accuracy were calculated. A p-value <0.05 was considered statistically significant.

Results: Demographic Distribution-

- Mean maternal age: 28.51±4.81 years
- Socioeconomic status: 43.4% Below Poverty Line (BPL), 56.6% Above Poverty Line (APL)
- Parity: 51% Primigravida, 49% Multigravida

Figure 1 : Distribution of Subjects by USG Doppler Indices

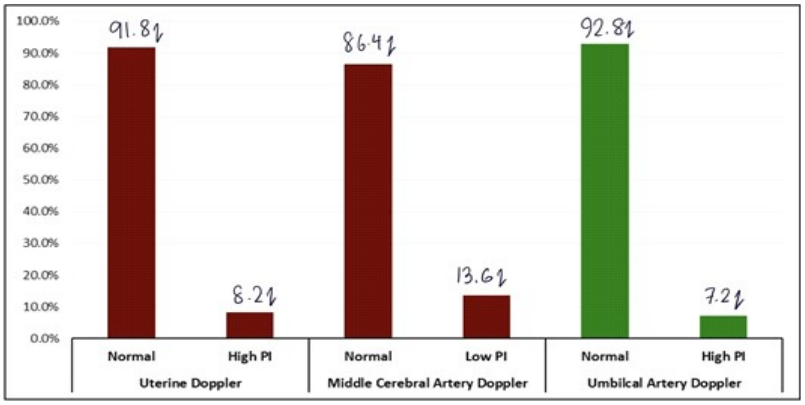


Figure-2 : Distribution of Subjects by Platelet Indices

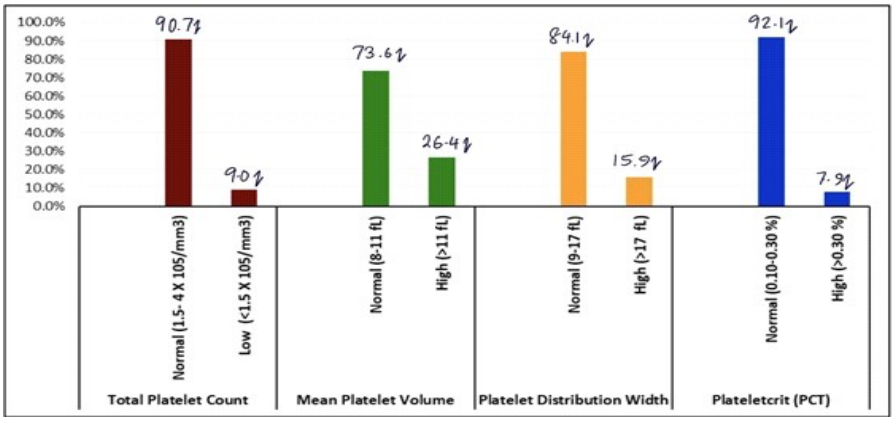


Table 1: Association of Utero-Placental Insufficiency by Platelet Indices with Individual Doppler Indices

Findings as per Individual Doppler Indices		Platelet Indices Collectively				Significance
		Any One Abnormal		All Normal		
		No. of Subjects (n=252)	Percentage	No. of Subjects (n=599)	Percentage	
Mean UtA PI	Normal (n=781)	211	83.7%	570	95.2%	$\chi2$=30.7, p< .001
	High PI (n=70)	41	16.3%	29	4.8%	
MCA PI	Normal (n=735)	207	82.1%	528	88.1%	$\chi2$=5.43, p= .020
	Low PI (n=116)	45	17.9%	71	11.9%	
UA PI	Normal (n=790)	215	85.3%	575	96.0%	$\chi2$=30.38, p<.001
	High PI (n=61)	37	14.7%	24	4.0%	

A statistically significant association between UPI as per high mean UtA PI and at least one abnormal platelet index was noted. A significant but less pronounced association between UPI detected by low MCA PI and abnormal platelet index. A significant association between UPI screened by high UA PI and at least one abnormal platelet index.

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Table 2: Distribution of Subjects by UPI on Basis of Platelet Indices & USG:

UPI by USG	UPI by Platelet Indices			
	At Least One Abnormal (n=252)		All Normal (n=599)	
Tested Positive (n= 158)	67	7.8%	91	15.2%
Tested Negative (n=693)	185	21.7%	508	84.8%
Significance	$\chi 2 = 15.23$, $p < .001$			
Sensitivity (95% CI)	42.4 (39.1 - 45.7)			
Specificity (95% CI)	73.3 (70.3 - 76.3)			
Positive Predictive Value (95% CI)	26.6 (23.6 - 29.6)			
Negative Predictive Value (95% CI)	84.8 (82.4 - 87.2)			
Diagnostic Accuracy (95% CI)	67.6 (64.4 - 70.7)			

Figure-3 : Bar Chart depicting the percentage of cases correctly identified as positive or negative for abnormal pregnancy outcomes due to UPI, by Maternal Platelet Indices-

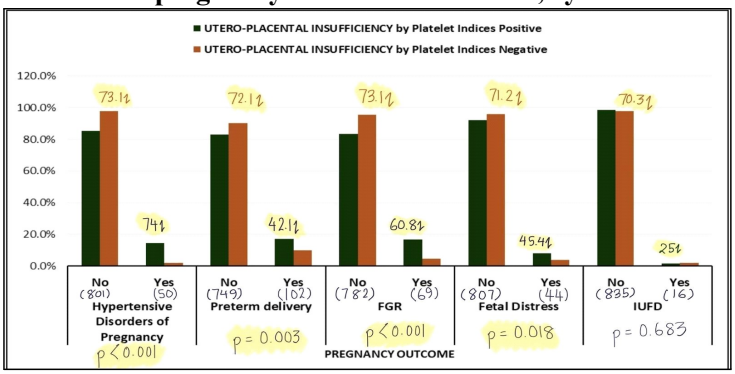
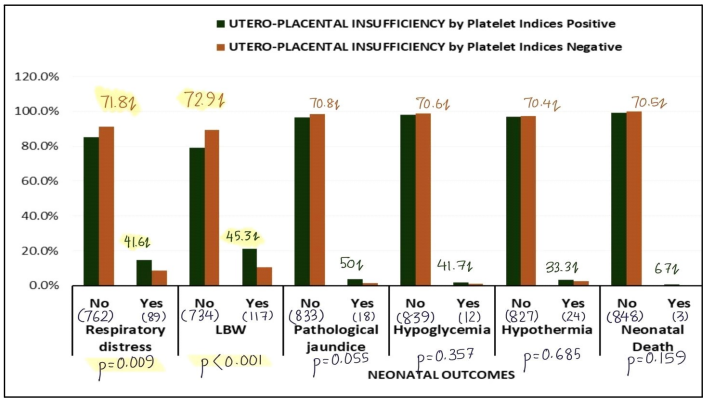


Figure-4 : Bar Chart depicting the percentage of cases correctly detected as positive or negative for abnormal neonatal outcomes due to UPI, by Maternal Platelet Indices-



Conclusion

From our study, we can conclude that at least one abnormal platelet index, that is, any one of low Total Platelet Count, high Mean Platelet Volume, high Platelet Distribution Width and/or high Plateletcrit is significantly associated with abnormal Ultrasound Doppler Indices- high mean Uterine Artery Pulsatility Index, high Umbilical Artery Pulsatility Index and/or low Middle Cerebral Artery Pulsatility Index.

Also, at least one abnormal platelet index is significantly associated with Antenatal complications- Hypertensive Disorders of Pregnancy, Preterm Births, Fetal Growth Restriction and Chronic Fetal Distress & Neonatal complications- Respiratory Distress and Low Birth Weight- pathologies arising due to placental involvement and Utero Placental Insufficiency developing in pregnancy.

Whereas, no significant association was noted with Neonatal Pathological Jaundice, Hypoglycemia, Hypothermia, IntraUterine Death or Neonatal Death.

Thus, Maternal Platelet Indices in first trimester can be used as non-invasive, cost-effective screening investigation, for UteroPlacental Insufficiency and for associated complications in pregnancy and neonate, in adjunction with Uterine Artery Doppler Indices in second upto third trimester and fetal Middle Cerebral Artery and Umbilical Artery Doppler Indices in third trimester.

If low Total Platelet Count, high Plateletcrit, high Platelet Distribution Width or high Mean Platelet Volume is observed early on in pregnancy preventive measures like administration of low dose Aspirin may be started before early on (16 weeks period) to not only prevent development of such complications in the mother but also decrease the neonatal complications.

Maternal Platelet Indices also may serve as a good screening test alone too in resource-limited settings where access to Doppler ultrasound is restricted.

Conflict of interest: None

Disclaimer: Nil

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