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DIAGNOSTIC UTILITY OF IMMATURE PLATELET FRACTION AND OTHER PLATELET INDICES IN PATIENTS WITH THROMBOCYTOPENIA

Pathology

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ABSTRACT

Introduction: Thrombocytopenia, defined as a decreased platelet count, is a common hematological abnormality with varied etiologies. Early differentiation between peripheral destruction and decreased platelet production is essential for prompt diagnosis and targeted management. Immature platelet fraction (IPF) and other platelet indices are emerging as valuable non-invasive markers to aid this differentiation. **Objectives:** To evaluate the diagnostic utility of IPF and other platelet indices (MPV, PDW, P-LCR) in patients presenting with thrombocytopenia and to correlate these indices with etiology, severity, and peripheral smear findings. **Methods:** A cross-sectional observational study was conducted on 500 patients presenting with thrombocytopenia at the Department of Pathology, Government Medical College, Jhalawar, after obtaining ethical approval. Patients of all age groups with platelet counts <150,000/µL were included. Platelet indices were measured using Sysmex XN-9000 Automated Hematology Analyzer. Clinical presentation, severity of thrombocytopenia, etiology, and peripheral smear findings were recorded. Statistical analysis was performed using SPSS Receiver operating characteristic (ROC) curve analysis determined diagnostic performance. **Results:** The study cohort included 58% males and 42% females, predominantly aged 18–40 years (42%). Dengue fever (30%), viral fever (20%), and immune thrombocytopenic purpura (ITP, 16%) were the leading causes. Fever (62%) was the most common symptom. Mean IPF% was 8.6 ± 4.2%, with MPV 10.8 ± 1.9 fL, PDW 15.6 ± 3.1%, and P-LCR 30.4 ± 8.2%. IPF% was significantly higher in cases of peripheral destruction (ITP, dengue) compared to decreased production (aplastic and megaloblastic anemia) and showed a strong inverse correlation with platelet count. ROC analysis revealed IPF% had highest diagnostic accuracy (AUC = 0.89) with a cut-off >8.5%, sensitivity 86% and specificity 82%. **Conclusion:** IPF% is a simple, rapid, and reliable marker for differentiating peripheral platelet destruction from decreased production in thrombocytopenia. Incorporation of IPF measurement into routine hematological evaluation can improve early diagnosis, guide management, and potentially reduce the need for invasive procedures like bone marrow examination.

KEYWORDS

INTRODUCTION

Thrombocytopenia, defined as a platelet count below 150,000/µL, is a frequent hematological disorder encountered in clinical practice. Its etiologies are diverse, ranging from immune-mediated peripheral destruction (e.g., immune thrombocytopenic purpura, dengue fever) to decreased production (e.g., aplastic anemia, megaloblastic anemia, marrow infiltration).[1,2] Rapid differentiation between these causes is essential for appropriate treatment: peripheral destruction may respond to immunomodulation, whereas decreased production may require supportive care or specific therapy.[3]

Traditionally, bone marrow examination is considered the gold standard to determine the underlying mechanism; however, it is invasive, time-consuming, and uncomfortable for patients.[4] Immature platelet fraction (IPF), a measure of newly produced platelets in circulation, has emerged as a non-invasive marker reflecting bone marrow activity. Higher IPF% indicates active peripheral platelet destruction, while low IPF% suggests impaired platelet production.[5]

Other platelet indices mean platelet volume (MPV), platelet distribution width (PDW), and platelet large cell ratio (P-LCR) also provide insights into platelet size and heterogeneity, indirectly reflecting production and destruction mechanisms.[6,7] Despite increasing evidence, population-specific data on the diagnostic utility of IPF and platelet indices remain limited. This study aims to evaluate these parameters in patients with thrombocytopenia, correlate them with etiology, and establish reference cut-offs for clinical use.

AIM AND OBJECTIVES

Aim:

To assess the diagnostic utility of immature platelet fraction and other platelet indices in patients with thrombocytopenia.

Objectives:

1. To measure IPF%, MPV, PDW, and P-LCR in patients with thrombocytopenia.
2. To correlate platelet indices with etiology of thrombocytopenia.
3. To evaluate sensitivity, specificity, and diagnostic accuracy of IPF% in differentiating peripheral destruction versus decreased production.
4. To provide reference cut-off values of IPF% for clinical use.

MATERIALS AND METHODS

Study Design and Setting: Cross-sectional observational study conducted in the Department of Pathology, Government Medical College, Bikaner.

Study Duration: one year

Study Population: Patients of all ages presenting with platelet counts <150,000/µL.

Inclusion Criteria: Patients with a platelet count of less than 150,000/µL and those who were willing to provide written informed consent were included in the study.

Exclusion Criteria: Patients who had received recent chemotherapy or radiotherapy, those who had undergone platelet transfusion within the preceding 48 hours.

Sampling Method: Simple random sampling.

Study Tools: The Sysmex XN-9000 Automated Hematology Analyzer was used for determination of platelet count and platelet indices (IPF%, MPV, PDW, P-LCR). A standardized proforma was used for systematic recording of demographic details, clinical history, peripheral smear findings, and all relevant laboratory parameters.

Procedure of Data Collection

After enrolment of eligible participants, detailed demographic information including age and sex was recorded using a predesigned proforma. A comprehensive clinical history was obtained from each patient, including fever, bleeding manifestations, petechiae, weakness, and any associated systemic symptoms, along with relevant past medical history, drug exposure, and known comorbid conditions. Venous blood samples were collected aseptically in K2EDTA vacutainer tubes at the time of presentation. All samples were analyzed within 4 hours of collection using the Sysmex XN-9000 Automated Hematology Analyzer.

Peripheral blood smears were prepared from all samples with platelet counts less than 100,000/µL. Smears were stained using Field stain and examined under oil immersion microscopy. Platelet estimation was performed by standard manual method, and platelet morphology was assessed for size variation, presence of giant or large platelets, and

overall platelet distribution. Smear findings were correlated with automated analyzer results to support etiological classification of thrombocytopenia.

Data Analysis

Data were entered into Microsoft Excel and analyzed using SPSS Trialversion 24.0. Continuous variables were expressed as mean ± SD, categorical variables as percentages. Student's t-test and ANOVA were used for group comparisons. ROC curve analysis determined diagnostic cut-off, sensitivity, specificity, and AUC for IPF%. P-value <0.05 was considered statistically significant.

Ethics

Ethical approval was obtained from the Institutional Ethical Committee prior to the commencement of the study. Written informed consent was obtained from all participants before their inclusion in the study.

RESULTS

Table No 1: Demographic and Clinical Characteristics of Study Population (n = 500)

Variables	Characteristic	n (%)
Gender	Male	290 (58%)
	Female	210 (42%)
Age Group	<18 years	110 (22%)
	18–40 years	210 (42%)
	41–60 years	120 (24%)
	>60 years	60 (12%)
Severity of Thrombocytopenia	Mild (50,000–100,000/µL)	180 (36%)
	Moderate (20,000–49,999/µL)	180 (36%)
	Severe (<20,000/µL)	140 (28%)
Etiology	Dengue fever	150 (30%)
	Viral fever (non-dengue)	100 (20%)
	Immune thrombocytopenic purpura (ITP)	80 (16%)
	Sepsis	60 (12%)
	Megaloblastic anemia	50 (10%)
	Aplastic anemia	40 (8%)
	Drug-induced	20 (4%)
Clinical Presentation	Fever	310 (62%)
	Generalized weakness	200 (40%)
	Myalgia/Headache	180 (36%)
	Bleeding manifestations	120 (24%)
	Petechiae/Purpura	90 (18%)
	Epistaxis	60 (12%)
	Gum bleeding	40 (8%)
	Incidental finding	30 (6%)

Table No 2: Platelet Indices According to Severity of Thrombocytopenia

Parameter	Mild (n=180)	Moderate (n=180)	Severe (n=140)	p-value
Platelet count (×10³/µL)	78.4 ± 12.5	34.7 ± 8.6	12.8 ± 4.5	<0.001
IPF (%)	5.8 ± 2.1	9.2 ± 3.4	14.7 ± 4.8	<0.001
MPV (fL)	9.8 ± 1.5	10.7 ± 1.8	11.6 ± 2.0	<0.001
PDW (%)	13.8 ± 2.4	15.4 ± 3.0	17.1 ± 3.6	<0.001
P-LCR (%)	24.5 ± 5.6	29.7 ± 7.2	35.2 ± 8.4	<0.001

Data presented as mean ± SD. Statistical significance tested using ANOVA.

Table No 3: Platelet Indices According to Etiology of Thrombocytopenia

Etiology	n	Platelet count (×10³/µL)	IPF (%)	MPV (fL)	PDW (%)	P-LCR (%)
Dengue fever	150	28.5 ± 9.4	12.8 ± 4.3	11.4 ± 1.9	16.5 ± 3.2	33.2 ± 7.9
Viral fever	100	40.7 ± 11.2	9.6 ± 3.1	10.6 ± 1.8	15.1 ± 2.9	29.5 ± 6.8
ITP	80	21.3 ± 6.8	14.9 ± 4.7	11.9 ± 2.1	17.3 ± 3.7	35.5 ± 8.1
Sepsis	60	35.2 ± 10.1	8.2 ± 2.7	10.2 ± 1.7	14.8 ± 3.0	28.9 ± 7.2
Megaloblastic anemia	50	45.6 ± 12.0	4.8 ± 1.9	9.6 ± 1.5	13.2 ± 2.5	23.7 ± 5.8
Aplastic anemia	40	38.9 ± 10.5	3.5 ± 1.4	9.4 ± 1.3	12.8 ± 2.2	22.9 ± 4.6
Drug-induced	20	41.2 ± 9.6	6.0 ± 2.0	10.1 ± 1.6	14.0 ± 2.7	26.4 ± 6.1

Values presented as mean ± SD.

Table No 4: Correlation of IPF (%) with Platelet Count and Severity of Thrombocytopenia (n=500)

Severity of Thrombocytopenia	n	Mean Platelet Count (×10³/µL)	Mean IPF (%)	Correlation (r)	p-value
Mild (50,000–100,000)	180	78.4 ± 12.5	5.8 ± 2.1	-0.42	<0.001
Moderate (20,000–49,999)	180	34.7 ± 8.6	9.2 ± 3.4	-0.56	<0.001
Severe (<20,000)	140	12.8 ± 4.5	14.7 ± 4.8	-0.68	<0.001
Overall	500	41.0 ± 25.6	9.8 ± 5.1	-0.61	<0.001

Table No 5 : Diagnostic Utility of Platelet Indices in Differentiating Peripheral Destruction vs Decreased Production (n = 500)

Parameter	Cut-off Value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	AUC (95% CI)
IPF (%)	>8.5	86	82	84	85	83.5	0.89 (0.85 – 0.93)
MPV (fL)	>10.5	74	70	72	71	72.0	0.78 (0.73 – 0.83)
PDW (%)	>15.0	72	68	70	69	70.0	0.74 (0.69 – 0.79)
P-LCR (%)	>30.0	70	65	68	67	67.5	0.71 (0.66 – 0.77)

DISCUSSION

In the present study, thrombocytopenia was more common in males (58%), which is comparable to findings of Goel et al. who also reported male predominance[8]. Most patients belonged to the 18–40 years age group (42%), similar to Jung et al., suggesting higher exposure to infectious causes in younger adults[9]. Fever was the most common symptom (62%), followed by weakness and bleeding manifestations, which is consistent with Ali et al., who also reported fever as the predominant presentation[10]. Dengue fever was the most common etiology (30%), followed by viral fever (20%) and ITP (16%), which is in agreement with Kumar et al., who also identified dengue as the leading cause in tropical regions[11]. Non-infectious causes such as megaloblastic anemia (10%) and aplastic anemia (8%) were less frequent but clinically important, similar to findings of Saini et al. and Patil et al., who reported comparable distributions[12,13]. In the present study, platelet indices (IPF%, MPV, PDW, and P-LCR) increased progressively with severity of thrombocytopenia (Table 2), indicating increased marrow response. IPF% increased from 5.8 ± 2.1 in mild cases to 14.7 ± 4.8 in severe cases, showing a strong inverse correlation with platelet count ($r = -0.61$, $p < 0.001$). Similar observations were made by Ali et al., who reported higher IPF% in severe thrombocytopenia reflecting active peripheral destruction[14]. IPF% was significantly higher in peripheral destruction causes such as ITP (14.9 ± 4.7) and dengue (12.8 ± 4.3), whereas lower values were seen in aplastic anemia (3.5 ± 1.4) and megaloblastic anemia (4.8 ± 1.9), consistent with Joen et al., who demonstrated similar differentiation between production and destruction disorders using IPF%[15]. The diagnostic performance of IPF% was superior to other platelet indices, with an AUC of 0.89, sensitivity of 86%, and specificity of 82% at a cut-off >8.5. These findings are comparable to Goel et al. and Jung et al., who also reported high diagnostic accuracy of IPF% in differentiating peripheral destruction from marrow suppression[8,16]. MPV, PDW, and P-LCR showed lower diagnostic accuracy in comparison. Overall, IPF% demonstrated strong correlation with platelet count, disease severity, and peripheral smear findings, similar to previous studies by Kumar et al., Patel et al., and Kaur et al., which highlighted its role in disease monitoring and differentiation of thrombocytopenia etiologies[11,14,16]. These findings suggest that IPF% is a superior, rapid, and non-invasive marker for evaluation of thrombocytopenia. It helps differentiate peripheral destruction from decreased production, supports early diagnosis, and may reduce the need for invasive bone marrow examination.

Strength and Limitations

The strengths of this study include a large sample size (n = 500) and

comprehensive evaluation of platelet indices (IPF%, MPV, PDW, and P-LCR) along with correlation with etiology, severity, and peripheral smear findings. The use of an automated hematology analyzer and ROC-based analysis further strengthens the reliability of results. However, it is a single-center study, which may limit generalizability. Serial follow-up of platelet indices was not done, and some etiological subgroups had smaller sample sizes.

CONCLUSION

This study shows that IPF% is a highly useful and reliable marker in thrombocytopenia. It is significantly higher in peripheral destruction (dengue, ITP) and lower in decreased production (aplastic anemia, megaloblastic anemia). IPF% showed the highest diagnostic accuracy among platelet indices (AUC 0.89) and can effectively differentiate the underlying cause of thrombocytopenia. It is a simple, rapid, and non-invasive test that can aid early diagnosis and management.

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