Section: Pathology

Original Research Article

DECODING THROMBOCYTOPENIA WITH PLATELET INDICES

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Received *: 20/04/2025*
Received in revised form *: 16/06/2025*
Accepted *: 04/07/2025*

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DOI: 10.70034/ijmedph.2025.3.128

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (3); 690-694

ABSTRACT

Background: A platelet count below 150,000/mm³ is classified as thrombocytopenia and is categorised into mild, moderate and severe. The integration of extended platelet indices into routine diagnostics has enhanced the ability to differentiate the causes of thrombocytopenia. **Aim:** To evaluate the clinical relevance of extended platelet indices (Mean Platelet Volume [MPV], Platelet Distribution Width [PDW], Platelet large cell ratio (P-LCR) and Plateletcrit [PCT]) in thrombocytopenia assessment, exploring their potential as additional diagnostic and prognostic markers.

Materials and Methods: This was prospective study conducted in tertiary care hospital on 50 thrombocytopenia cases. Platelet indices were measured using 6-part automated hematology analyser and peripheral smears were reviewed. Patients were categorized by etiology, thrombocytopenia severity and mechanism (hyperdestructive vs. hypoproliferative), results were analysed across these subgroups.

Results: The study comprised 50 patients diagnosed with thrombocytopenia. The majority of participants (36%) were between 41–60 years with 48% male and 52% females. The most common cause of thrombocytopenia was sepsis (28%), followed by dengue fever (22%) and viral infections (16%). Majority of the cases had moderate thrombocytopenia (52%). Analysis of platelet indices across different causes of thrombocytopenia demonstrated distinct variations.

Conclusion: The extended platelet indices (Mean Platelet Volume [MPV], Platelet Distribution Width [PDW], Platelet large cell ratio [P-LCR] and Plateletcrit [PCT]) offer insight into thrombocytopenia causes and prognosis. Integrating platelet indices could reduce unnecessary procedures like bone marrow biopsies.

Keywords: Mean Platelet Volume, Platelet Distribution Width, Platelet large cell ratio, Plateletcrit.

INTRODUCTION

Platelets, also known as thrombocytes, are anucleate cellular components of blood measuring 2–4 micrometers in size. They are derived from megakaryocytes in the bone marrow through a process called thrombopoiesis. These disk-shaped, membrane-bound structures play a vital role in hemostasis by activating coagulation factors during vascular injury, facilitating clot formation, and preventing excessive bleeding. The normal lifespan of platelets ranges from 7–10 days, with a count typically between 150,000 to 400,000/mm³ in healthy individuals. A platelet count below 150,000/mm³ is classified as thrombocytopenia, a condition associated with various underlying pathologies, including immune disorders, infections, and bone marrow diseases.[1]

Thrombocytopenia is further categorized into mild (100,000–150,000/mm³), moderate (20,000–50,000/mm³), and severe (<20,000/mm³) based on platelet levels. Severe thrombocytopenia is often linked to significant bleeding risks, including spontaneous bleeding when levels drop below 5,000/mm³.[2] Among the various etiologies, immune thrombocytopenia (ITP) is a notable immune-mediated disorder characterized by excessive platelet destruction and impaired megakaryopoiesis. The exact pathophysiology of ITP remains elusive but involves mechanisms such as platelet autoantibody production and T-cell-mediated destruction, leading to clinical manifestations like bruising, epistaxis, and mucocutaneous bleeding.[3]

Advancements in hematological technology have introduced automated analyzers capable of providing extended platelet indices, including platelet count (PLT), mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT), immature platelet fraction (IPF), and platelet-large cell ratio (P-LCR). These indices are essential for evaluating platelet morphology, volume, and activation. Elevated MPV (>13 fl) suggests increased platelet turnover due to hyperdestruction, while low MPV (<8 fl) indicates reduced production, offering insights into differentiating between hyperdestructive and hypoproliferative thrombocytopenia.[4] Similarly, parameters like PDW and P-LCR are elevated in destructive thrombocytopenias, reflecting platelet size variability and activation.

The integration of these indices into routine diagnostics has enhanced the ability to differentiate the causes of thrombocytopenia. Despite their potential, parameters like IPF and P-LCR remain underutilized in clinical practice. This study aims to evaluate platelet indices in thrombocytopenic patients to establish their diagnostic significance. By elucidating the utility of these indices, this research contributes to a more nuanced understanding of thrombocytopenia and its underlying mechanisms.

Aims and Objectives

1. To evaluate the clinical relevance of extended platelet indices (Mean Platelet Volume [MPV], Platelet Distribution Width [PDW], Platelet large cell ratio (P-LCR) and Plateletcrit [PCT]) in thrombocytopenia assessment, exploring their potential as additional diagnostic and prognostic markers.
2. To determine the utility of platelet indices in differentiating the causes of thrombocytopenia i.e hyperdestructive and hypoproliferative thrombocytopenia.

MATERIALS AND METHODS

Study Design: Prospective study
Setting: Tertiary care Centre
Population: 50 thrombocytopenia cases.

Inclusion Criteria

- Confirmed thrombocytopenia on automated blood analysis.

Exclusion Criteria

- Known hematological malignancies.
- Incomplete data.

Sample Collection

- Volume: 2 ml venous blood in K3 EDTA vials.
- Analysis: 6 part automated haematology analyser.
- Parameters: Platelet count, MPV, PDW, PCT, P-LCR
- Peripheral Smears: Prepared and stained with Leishman stain for cross-verification.

Cut off Values

- Normal Platelet count=150000-450000 /cmm
- Normal MPV=7.5-11.5 fl
- Normal PDW=9-16.5 %
- Normal PCT = 0.22-0.24 %
- Norma P-LCR= 13-35 %
- Thrombocytopenia Severity:
  - Mild: 100,000–150,000/µl.
  - Moderate: 50,000–100,000/µl.
  - Severe: <50,000/µl.

RESULTS

The study comprised 50 patients diagnosed with thrombocytopenia. The majority of participants (36%) were between 41–60 years, followed by 18–40 years (34%) and those above 60 years (28%). (Table 1). A smaller proportion (2%) were under 18 years. The study population was nearly evenly distributed by sex, with 24 males (48%) and 26 females (52%). (Table 1.) (Fig 1.)

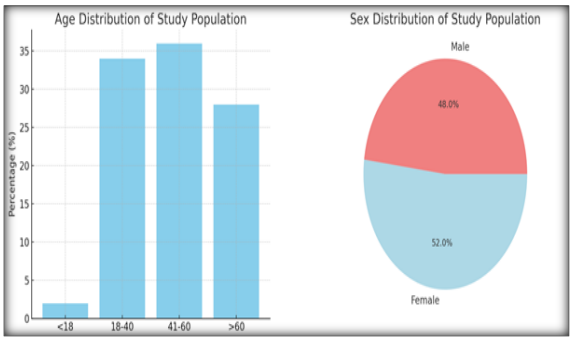

Figure 1: Age and sex destribution

Table 1: Demographic Characteristics of the Study Population

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	<18	1	2%
	18–40	17	34%
	41–60	18	36%
	>60	14	28%
	Total	50	100%

Sex	Male	24	48%
	Female	26	52%
	Total	50	100%

The most common cause of thrombocytopenia was sepsis (28%), followed by dengue fever (22%) and viral infections (16%). Other notable causes included coronary artery disease (10%), megaloblastic anemia (10%), immune thrombocytopenia (ITP) (8%), malaria (4%), and pre-eclampsia (2%). The diversity of etiological factors highlights the multifactorial nature of thrombocytopenia in clinical practice. (Table 2a, 2b)

Table 2a: Causes of Thrombocytopenia

Cause	Frequency (n)	Percentage (%)
Sepsis	14	28%
Dengue	11	22%
Viral Infection	8	16%
ITP (Immune Thrombocytopenia)	4	8%
Pre-Eclampsia	1	2%
Coronary Artery Disease	5	10%
Megaloblastic Anaemia	5	10%
Malaria	2	4%
Total	50	100%

Table 2b: Distribution of cases into Hyperdestructive and Hypoproliferative Thrombocytopenia

	Hyperdestructive Thrombocytopenia	Hypoproliferative Thrombocytopenia
Sepsis	28%	-
Dengue	22%	-
Viral Infection	16%	-
ITP (Immune Thrombocytopenia)	8%	-
Pre-Eclampsia	2%	-
Coronary Artery Disease	10%	-
Malaria	4%	-
Megaloblastic Anaemia	-	10%
Total -(100)	90 %	10 %

Among the study participants, the majority had moderate thrombocytopenia (52%), with platelet counts ranging from 50,000 to 99,999/mm³. Mild thrombocytopenia (100,000–150,000/mm³) was observed in 44% of cases, whereas severe thrombocytopenia (<50,000/mm³) was rare, affecting only 4% of patients. (Table 3)

Table 3: Severity of Thrombocytopenia

Severity	Platelet Count Range	Frequency (n)	Percentage (%)
Mild	100,000–150,000	22	44%
Moderate	50,000–99,999	26	52%
Severe	<50,000	2	4%

Among the participants, MPV, PDW, P-LCR is highest among older age group (> 60 years). (Table 4.) (Fig 2.)

Table 4: Platelet Indices by Age Group

Age Group (years)	MPV (fL)	PDW (fL)	PCT (%)	P-LCR (%)
<18	10.5 ± 0.7	12.8 ± 2.5	0.08 ± 0.02	26.5 ± 5.0
18–40	11.3 ± 1.0	15.2 ± 3.2	0.10 ± 0.03	37.8 ± 6.8
41–60	11.7 ± 1.1	16.5 ± 3.8	0.11 ± 0.03	40.5 ± 7.5
>60	12.0 ± 1.2	17.8 ± 4.0	0.09 ± 0.03	42.0 ± 8.2

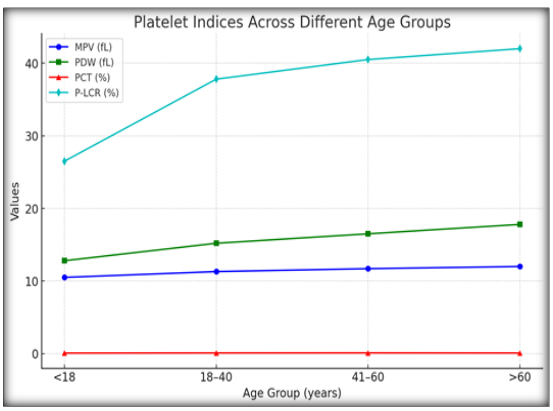

Figure 2: Platelet indices across different age groups

Analysis of platelet indices across different causes of thrombocytopenia demonstrated distinct variations. MPV was observed to be highest in hyperdestructive causes, maximum contributed by ITP (12.0 ± 0.7 fL), followed by sepsis (11.6 ± 0.8). Where as hypoproliferative causes eg. megaloblastic anemia had relatively lower MPV as compared to hyperdestructive causes.

Platelet distribution width (PDW) was observed to be high in hyperdestructive cases i.e sepsis (16.5 ± 3.2 fL), followed by dengue (15.8 ± 4) whereas hypoproliferative cases show relatively lower PDW. Plateletcrit (PCT) was highest in hypoproliferative cases i.e megaloblastic anemia (0.15 ± 0.02%) and

lowest in hyperdestructive cases i.e sepsis (0.08 ± 0.03%), viral infections (0.12 ± 0.03%), dengue (0.10 ± 0.04%) and ITP (0.09 ± 0.02%). The platelet large cell ratio (P-LCR) remained highest in sepsis (39.2 ± 5.1%) and megaloblastic anemia (38.7 ± 9.1%).

These findings suggest that platelet indices vary significantly depending on the underlying cause of thrombocytopenia, which may aid in differential diagnosis. (Table 5)

Table 5: Platelet Indices by Cause of Thrombocytopenia

Cause	MPV (fL)	PDW (fL)	PCT (%)	P-LCR (%)
Sepsis	11.6 ± 0.8	16.5 ± 3.2	0.08 ± 0.03	39.2 ± 5.1
Dengue	11.2 ± 1.1	15.8 ± 4.0	0.10 ± 0.04	37.5 ± 8.2
Viral Infection	11.4 ± 1.3	14.2 ± 3.5	0.12 ± 0.03	35.8 ± 7.6
ITP	12.0 ± 0.7	13.0 ± 1.0	0.09 ± 0.02	38.6 ± 4.3
Megaloblastic Anaemia	11.3 ± 1.0	14.3 ± 2.8	0.15 ± 0.02	38.7 ± 9.1

Regarding sex-based differences, males exhibited slightly higher MPV (11.5 ± 1.0 fL) and PDW (15.8 ± 3.5 fL) compared to females (11.4 ± 1.1 fL and 15.2 ± 3.8 fL, respectively). (Table 6)

Table 6: Platelet Indices by Sex Distribution

Sex	MPV (fL)	PDW (fL)	PCT (%)	P-LCR (%)
Male	11.5 ± 1.0	15.8 ± 3.5	0.10 ± 0.03	38.5 ± 7.0
Female	11.4 ± 1.1	15.2 ± 3.8	0.11 ± 0.03	37.8 ± 7.5

DISCUSSION

This study aimed to evaluate the demographic characteristics, etiological factors, severity, and platelet indices in patients diagnosed with thrombocytopenia. The findings provide valuable insights into the clinical and diagnostic aspects of thrombocytopenia, highlighting the importance of platelet indices in understanding the underlying causes and severity of the condition. Below is a detailed discussion of the results, organized thematically.

Demographic Characteristics

The study population comprised 50 patients, with a nearly equal distribution of males (48%) and females (52%). The majority of participants were aged 41–60 years (36%), followed by those aged 18–40 years (34%) and above 60 years (28%). A small proportion (2%) were under 18 years. This age distribution reflects the common occurrence of thrombocytopenia in middle-aged and older adults, likely due to the higher prevalence of chronic diseases and infections in these age groups. The balanced sex distribution suggests that thrombocytopenia affects both males and females equally, consistent with findings from previous studies .[5,6]

Etiological Factors

The most common cause of thrombocytopenia in this study was sepsis (28%), followed by dengue fever (22%) and viral infections (16%). Other notable causes included coronary artery disease (10%), megaloblastic anemia (10%), immune thrombocytopenia (ITP) (8%), malaria (4%), and pre-eclampsia (2%). The predominance of sepsis and dengue as leading causes aligns with global trends, particularly in regions where infectious diseases are prevalent according to literature.[7] The diversity of etiological factors underscores the multifactorial nature of thrombocytopenia, necessitating a thorough diagnostic workup to identify the underlying cause.

Severity of Thrombocytopenia

The majority of patients (52%) had moderate thrombocytopenia (platelet count: 50,000–99,999/mm³), while 44% had mild thrombocytopenia (100,000–150,000/mm³). Only 4% of patients had severe thrombocytopenia (<50,000/mm³). These findings are consistent with previous studies, which report that moderate thrombocytopenia is the most frequently observed severity level in clinical settings.[8] The low prevalence of severe thrombocytopenia in this study may reflect early diagnosis and intervention, preventing progression to severe stages.

Platelet Indices by Cause of Thrombocytopenia

Analysis of platelet indices revealed distinct patterns based on the underlying cause of thrombocytopenia:

- Mean Platelet Volume (MPV): Highest in patients with ITP (12.0 ± 0.7 fL) and lowest in those with dengue fever (11.2 ± 1.1 fL). Elevated MPV in ITP may reflect increased platelet turnover, while lower MPV in dengue could indicate bone marrow suppression.
- Platelet Distribution Width (PDW): Highest in sepsis (16.5 ± 3.2 fL) and lowest in ITP (13.0 ± 1.0 fL). Increased PDW in sepsis suggests greater variability in platelet size due to inflammatory processes.
- Plateletcrit (PCT): Highest in megaloblastic anemia (0.15 ± 0.02%) and lowest in sepsis (0.08 ± 0.03%). Low PCT in sepsis may reflect reduced platelet production or increased destruction.
- Platelet Large Cell Ratio (P-LCR): Highest in sepsis (39.2 ± 5.1%) and megaloblastic anemia (38.7 ± 9.1%), indicating a higher proportion of large, immature platelets in these conditions.

These findings highlight the diagnostic utility of platelet indices in differentiating the causes of thrombocytopenia, as previously reported.[9]

Platelet Indices by Age and Sex

- Age: MPV, PDW, and P-LCR increased progressively with age, with the highest values observed in patients older than 60 years. This trend may reflect age-related changes in platelet production and turnover, as well as the higher prevalence of chronic diseases in older adults.

Sex**:** Males exhibited slightly higher MPV and PDW compared to females, but these differences were not statistically significant. This finding aligns with previous research, which reports minimal sex-based differences in platelet indices (Lee et al., 2017).[10]

CONCLUSION

The extended platelet indices (Mean Platelet Volume [MPV], Platelet Distribution Width [PDW], Platelet large cell ratio [P-LCR] and Plateletcrit [PCT]) offer insight into thrombocytopenia causes and prognosis. Integrating platelet indices could reduce unnecessary procedures like bone marrow biopsies.

Acknowledgment: Nil
Funding: Nil
Conflict of interest: Nil

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