Original Article

Platelet Indices as Surrogates for Bone Marrow Function in Thrombocytopenia

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Abstract

Background: Thrombocytopenia is the decrease in circulating platelet count to below 150,000/mm^3, typically resulting from either increased peripheral destruction or impaired production within the bone marrow. This study aims to evaluate the diagnostic utility of platelet indices—namely, Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), and Platelet Large Cell Ratio (P-LCR)—in differentiating hypoproductive from hyperdestructive causes of thrombocytopenia.

Methods: A prospective, cross-sectional study was conducted over a two-year period involving 200 systematically sampled patients with thrombocytopenia. Platelet indices were measured using an automated hematology analyzer, and their values were statistically compared between hypoproductive and hyperdestructive groups.

Results: The highest incidence of thrombocytopenia was observed in individuals aged 36–50 years, with a slight male predominance. Severe thrombocytopenia (platelet count $<$50,000/mm^3) was noted in 94 cases (47%). The hyperdestructive group exhibited significantly higher mean values for MPV (10.70 fL vs. 9.22 fL), PDW (16.13 fL vs. 11.21 fL), and P-LCR (39.48% vs. 22.83%) compared to the hypoproductive group, with all differences reaching statistical significance ($p < 0.05$). Bone marrow aspiration was performed in 13 of the 142 hyperdestructive cases, with 12 (92.3%) diagnosed as immune thrombocytopenic purpura (ITP). All 58 patients in the hypoproductive group underwent bone marrow evaluation, with megaloblastic anemia identified in 29 cases (50%).

Conclusion: Platelet indices such as MPV, PDW, and P-LCR serve as valuable, non-invasive markers in the initial differentiation of thrombocytopenia etiology. Their routine use may aid in distinguishing between hypoproductive and hyperdestructive mechanisms, thereby guiding appropriate diagnostic workup and clinical management.

Keywords: platelet count; thrombocytopenia; Bone marrow aspiration; immune thrombocytopenic purpura

Introduction

Thrombocytopenia is one of the most commonly encountered hematological abnormalities in clinical practice. Platelets are small, anucleate cytoplasmic fragments derived from bone marrow megakaryocytes, typically measuring 3–5 μm in diameter and possessing an average lifespan of 7–10 days. Thrombocytopenia is defined as a platelet count below 150,000/mm^3 in peripheral blood and may result from four primary mechanisms: spurious (artefactual) thrombocytopenia, decreased platelet production, increased peripheral destruction, and abnormal sequestration or redistribution of platelets within the vascular system [1, 2]. Among these, the two principal pathological mechanisms are either peripheral hyperdestruction or impaired production in the bone marrow [3].

Modern automated hematology analyzers have enhanced the ability to detect and evaluate hematologic abnormalities, including thrombocytopenia, by providing various platelet indices. These include Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), Plateletcrit (PCT), Platelet Large Cell Ratio (P-LCR), and Immature Platelet Fraction (IPF).

These indices aid in differentiating between thrombocytopenia caused by peripheral destruction and that due to reduced marrow production. They are also useful in detecting the presence of giant platelets, platelet anisocytosis, and aggregation.

The MPV, with a normal range of 7–11 fL, reflects the average size of platelets and serves as a marker of platelet production and activation. An increased MPV suggests the presence of larger, more reactive platelets, often seen in destructive thrombocytopenias, while a decreased MPV is typically observed in hypoproductive states [4]. PDW, normally ranging from 9–14 fL, indicates variability in platelet size, serving as a marker of anisocytosis. P-LCR measures the proportion of large platelets (>12 fL) and is frequently elevated in hyperdestructive conditions associated with the presence of giant platelets [5].

Although these indices have been known for years and extensively studied, especially in isolation, their potential remains underutilized in routine clinical decision-making. This study aims to evaluate the diagnostic utility of MPV, PDW, and P-LCR in distinguishing between hypoproductive and hyperdestructive causes of thrombocytopenia.

Materials and Methods

This prospective cross-sectional study was conducted in the Clinical Pathology Laboratory, Department of Pathology, KIMS & RF, Amalapuram, over a two-year period from September 2022 to August 2024. The study population comprised patients aged above 5 years with thrombocytopenia, defined as a platelet count of less than 150,000/mm^3. A total of 200 cases were selected using systematic random sampling. Patients below 5 years of age and those who had received recent blood or blood component transfusions were excluded from the study. Two milliliters of venous blood were collected from each patient in a vacutainer containing potassium ethylenediaminetetraacetic acid (K_2EDTA) and processed for complete blood counts using an automated hematology analyzer (Sysmex XN-350 model). Thrombocytopenia cases were identified from the analyzer-generated hemogram reports on a daily basis.

For all cases with platelet counts <150,000/mm^3, peripheral blood smears were prepared and stained with Leishman stain according to standard protocols [6]. Thrombocytopenia was confirmed microscopically. Platelet indices—Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), and Platelet Large Cell Ratio (P-LCR)—were recorded from the hematology analyzer reports. Additional peripheral smear findings and relevant clinical data were documented, along with results from serological investigations and bone marrow examinations, wherever available.

Based on clinical and hematological evaluations, patients were categorized into two groups: Hypoproductive thrombocytopenia (n = 58): All patients in this group underwent bone marrow examination. Hyperdestructive thrombocytopenia (n = 142): Bone marrow examination was conducted only when clinically indicated.

The results of bone marrow studies were analyzed and correlated with the underlying etiological diagnosis. Platelet indices (MPV, PDW, P-LCR) were compared between the two groups to assess their diagnostic utility in differentiating between hypoproductive and hyperdestructive thrombocytopenia. Data were compiled and statistically analyzed using SPSS software version 20.0 and Microsoft Excel 2019. Appropriate statistical tests were applied to determine the significance of differences in platelet indices between the two study groups. The study protocol was reviewed and approved by the Institutional Ethics and Research Committee of KIMS & RF, Amalapuram, prior to commencement of the study. Informed consent was obtained from all participants.

Results

Out of 200 cases of thrombocytopenia, the highest number of thrombocytopenia cases was seen in the age group of 36–50 years—60 cases (30.2%), showing a slight male predominance (114 males: 86 females).

Based upon clinical details and etiology, 142 cases, out of 200 cases of thrombocytopenia, were categorized into the hyperdestructive group and the remaining 58 cases were categorized into the hypoproductive group. Table 1 shows the etiological distribution of these cases in the hyperdestructive group and Table 2 in the hypoproductive group.

Of the 200 cases, 94 patients (47%) had severe thrombocytopenia (platelet count <50,000/mm^3), 87 patients (43.5%) had moderate thrombocytopenia (50,000–100,000/mm^3), and 19 patients (9.5%) had mild thrombocytopenia (100,000–150,000/mm^3). This shows that nearly half the patients presented with critically low platelet levels, underlining the clinical importance of timely evaluation and differentiation of etiology.

Statistically significant p-value was observed with all platelet indices in both the groups (Table 3).

Out of 142 hyperdestructive thrombocytopenia cases, bone marrow aspiration was done in 13 cases (9.1%) and in 58 hypoproductive thrombocytopenia cases, bone marrow aspiration was done in all 58 cases (100%). The reason for the lower number of bone marrow aspirations among the hyperdestructive group is because steroid treatment was initiated by the treating physicians, based on the preliminary platelet indices and majority of them showed improvement. Hence,

they were not referred for further evaluation by bone marrow aspiration. Among the hyperdestructive group, 12 cases were diagnosed with ITP, showing increased megakaryocyte numbers, a classical finding in peripheral platelet destruction. The remaining one case, attributed to hypersplenism, also revealed increased megakaryocytes. These findings confirm that marrow compensatory response is typically preserved in destructive thrombocytopenia. Table 4 shows the bone marrow findings in the hypoproductive group.

Table 1: Etiological distribution of cases in the hyperdestructive group

Diagnosis	No of cases (n)	Percentage (%)
Acute pancreatitis	1	0.7
Chronic Liver disease	1	0.7
Chronic Pancreatitis	3	2.1
CKD	2	1.4
Sepsis	5	3.5
Hemolytic reaction	1	0.7
Hypersplenism	1	0.7
ITP	12	8.4
Malaria	3	2.1
Typhoid	2	1.4
Dengue	78	55.0
Other Viral fevers	33	23.3
Total	**142**	**100.0**

Table 2: Etiological distribution of cases in the hypoproductive group

Diagnosis	No of cases (n)	Percentage (%)
ALL	7	12.0
AML	8	13.7
Aplastic Anemia	4	6.9
CML	5	8.7
Megaloblastic Anemia	29	50.0
NHL	5	8.7
Total	**58**	**100.0**

Table 3: Statistical analysis of each platelet indices in each group

Variables	Group	n	Mean	Std. Dev.	Std. Error Mean	p-value
Platelet Count/mm^3	Hyperdestructive	142	62.14	29.02	2435.461	0.002
	Hypoproductive	58	46.87	34.70	4596.506	
MPV (fL)	Hyperdestructive	142	10.699	1.1014	0.0924	<0.0001
	Hypoproductive	58	9.219	0.9404	0.1246	
PDW (fL)	Hyperdestructive	142	16.133	1.8825	0.1580	<0.0001
	Hypoproductive	58	11.209	2.0970	0.2778	
P-LCR (%)	Hyperdestructive	142	39.479	6.6395	0.5572	<0.0001
	Hypoproductive	58	22.825	5.9297	0.7854	

Table 4: Bone marrow findings in hypoproductive group

Clinical diagnosis	No of cases	No. of megakaryocytes in bone marrow
ALL	7 (12%)	Decreased
AML	8 (13.7%)	Decreased
Aplastic Anemia	4 (6.9%)	Decreased
CML	5 (8.7%)	Decreased
Megaloblastic Anemia	29 (50%)	Decreased
NHL	5 (8.7%)	Decreased

Discussion

The findings of this study reaffirm the utility of platelet indices—such as Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), and Platelet Large Cell Ratio (P-LCR)—in evaluating the underlying causes of thrombocytopenia. These indices, easily obtained from automated hematology analyzers, offer a rapid, cost-effective, and objective assessment, eliminating inter-observer variability and minimizing the need for invasive investigations such as bone marrow aspiration [7].

In our cohort, patients ranged in age from 6 to 75 years, with the highest prevalence of thrombocytopenia observed in the 36–50-year age group. This demographic trend is consistent with the findings reported by Peddaverannagari T et al. [8], Khairkar et al. [9], and Mittal V et al. [10]. A slight male predominance was noted (57%), aligning with previous studies by Bhalara SK et al. [11], Choudhary M et al. [12], Suresh et al. [13], and Francis et al. [14].

Infectious etiologies accounted for the majority (78.8%) of thrombocytopenia cases, with dengue fever alone constituting 55%. This is comparable to the study by Francis et al. [14], where dengue contributed to 63.1% of the cases. Other studies by Yalavarthi et al. [15] and Mala et al. [16] also reported high infection-related thrombocytopenia rates at 85.5% and 60.2%, respectively.

Immune thrombocytopenic purpura (ITP) represented 8.4% of cases in the current study, which is in line with the incidence reported by Gulati et al. [17] (8.9%) and Francis et al. [14] (11.6%).

Hypoproductive thrombocytopenia accounted for 29% of total cases (n = 58), with megaloblastic anemia being the predominant cause (50%), followed by acute leukemias (25.7%). These results are consistent with Gulati et al. [17], who documented megaloblastic anemia in 52.4% of similar cases.

Regarding platelet counts, the mean platelet count in the hyperdestructive group was $62.14 \pm 29.02 \times 10^3/mm^3$, comparable to the findings of Zulfania et al. [18]. In the hypoproductive group, the mean count was $46.87 \pm 34.70 \times 10^3/mm^3$, echoing the results from Khairkar et al. [9] and Elsewefy et al. [19].

MPV, a marker of platelet size and reactivity, was significantly higher in the hyperdestructive group (10.69 ± 1.10 fL) compared to the hypoproductive group (9.21 ± 0.94 fL), with a p-value of <0.0001. These findings correlate with studies by Khairkar et al. [9], Borkataky et al. [20], Ntaios et al. [21], Elsewefy et al. [19], Kaito et al. [22], and Parveen et al. [1]. Variations in MPV values across studies may be attributed to differences in hematology analyzers, time of analysis post-venepuncture, type of anticoagulant used, storage conditions, and counter technologies.

Similarly, PDW was significantly elevated in the hyperdestructive group compared to the hypoproductive group (p-value = <0.0001), reinforcing its role in reflecting platelet anisocytosis in peripheral destruction. P-LCR, an indicator of the proportion of larger platelets, was also significantly higher in the hyperdestructive group (p-value = <0.0001), suggesting its potential as a useful marker in differentiating causes of thrombocytopenia.

Bone marrow examination findings in ITP cases revealed increased megakaryocytes, indicative of compensatory marrow response to peripheral platelet destruction. Conversely, bone marrow samples from hypoproductive thrombocytopenia patients consistently demonstrated decreased megakaryocytes, supporting a defect in platelet production.

The bone marrow findings in this study align well with the variations observed in platelet index values across the two thrombocytopenia groups. In the hypoproductive group, bone marrow examination was performed in all 58 cases and consistently revealed a decreased number of megakaryocytes, reflecting impaired platelet production. Correspondingly, these patients exhibited significantly lower values of MPV, PDW, and P-LCR, indicating smaller, more uniform platelets due to diminished marrow activity. In contrast, although bone marrow aspiration was performed in only a subset (13 cases) of the hyperdestructive group, nearly all of them (92.3%) showed increased megakaryocyte numbers—demonstrating an intact or compensatory marrow response to peripheral platelet destruction. This finding was mirrored in their platelet indices, with significantly elevated MPV, PDW, and P-LCR values, indicating the release of larger, more heterogeneous platelets into circulation. These correlations substantiate the utility of platelet indices as surrogate markers of underlying marrow activity, reinforcing their diagnostic value in differentiating between hypoproductive and hyperdestructive thrombocytopenia, potentially reducing the need for bone marrow aspiration in appropriate clinical settings.

Limitations: Firstly, bone marrow examination was performed in only a small subset of patients within the hyperdestructive thrombocytopenia group, limiting definitive correlation between platelet indices and marrow findings in this category. As a single-center study conducted at a tertiary care institution, the results may not be generalizable to broader or more diverse populations. The cross-sectional nature of the study also restricted the evaluation of temporal changes in platelet indices and their utility in monitoring disease progression or therapeutic response. Furthermore, despite standardization, pre-analytical variables such as the time interval between sample collection and analysis, and storage conditions could have influenced platelet index values.

Conclusion

This study underscores the clinical value of platelet indices—specifically Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), and Platelet Large Cell Ratio (P-LCR)—as accessible, non-invasive diagnostic tools in the evaluation of thrombocytopenia. The statistically significant differences in these indices between hypoproductive and hyperdestructive groups closely reflected the corresponding bone marrow findings, with lower indices and reduced megakaryocytes seen in hypoproductive cases, and elevated indices with preserved or increased megakaryopoiesis in hyperdestructive cases. These findings highlight that platelet indices, routinely generated by automated hematology analyzers, can serve as reliable surrogate markers to differentiate the underlying etiology of thrombocytopenia, especially in resource-limited settings where invasive diagnostic procedures like bone marrow examination may not be readily available. Incorporating these parameters into routine diagnostic protocols can facilitate earlier, targeted clinical decision-making and reduce the dependence on invasive investigations.

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References

1. Parveen S, Vimal M. Role of platelet indices in differentiating hypoproductive and hyperdestructive thrombocytopenia. Ann Pathol Lab Med. 2017;4(3):A288–91.
2. Strau G, Vollert C, Von Stackelberg A, Weimann A, Gaedicke G, Schulze H. Immature platelet count. A simple parameter for distinguishing thrombocytopenia in pediatric acute lymphocytic leukemia from immune thrombocytopenia. Pediatr Blood Cancer. 2011;57:641.
3. Negash M, Tsegaye A, Medhin G. Diagnostic utility of platelet indices for discriminating hypo productive versus immune thrombocytopenia purpurpura in patients attending a tertiary care hospital in Addis Ababa, Ethiopia. BMC hematology. 2016;16.
4. Shah AR, Chaudhari SN, Shah MH. Role of platelet parameters in diagnosing various clinical conditions. Natl J Med Res 2013;3(2):162-165.
5. Briggs C. Quality counts: new parameters in blood cell counting. Int J Lab Hematol. 2009;31(3):277–97.
6. K.T. N, Prasad K, Singh BMK. Analysis of red blood cells from peripheral blood smear images for anemia detection: a methodological review. Med Biol Eng Comput 2022;60(9):2445–62.
7. Vidyadhar S. Diagnostic Implication and Utility of Platelet Indices in Differentiating Hypoproductive and Hyperdestructive Thrombocytopenia. IOSR J of dental and medical sciences. 2019;18(8):7-11.
8. Peddaverannagari T, Chakkirala N, Prabhala S, et al. Utility of platelet count and platelet indices in the evaluation of thrombocytopenia. J Evid Based Med Healthc 2020; 7(49):2974-80.
9. Khairkar SP, More S, Pandey A et al. Role of mean platelet volume(MPV)in diagnosing categories of thrombocytopenia. Indian journal of pathology and Oncology 2016;3(4):606-610.
10. Mittal V, Bali IK. Study of platelet indices and their interpretation in thrombocytopenia in a tertiary care hospital. J Evolution Med Dent Sci. 2021;10(07):435–9.
11. Bhalara SK, Shah S, Goswami H, Gonsai RN. Clinical and etiological profile of thrombocytopenia in adults: A tertiary care hospital based cross-sectional study. Int J Med Sci Public Health 2015;4:7-10.
12. Choudhary MK, Lohani KK, Paswan NK. Study of Clinical Profile of Acute febrile illness with thrombocytopenia. JMSCR 2017;05(06):24068-70.
13. Suresh P, Devi CY, Kumar CR, Jalaja Y. Evaluation of the Cause in Fever with Thrombocytopenia Cases. J of Evidence Based Med & Healthcare. 2015;2(15):2134-37.
14. Francis R, Shetageri SN, Roopa AN, Parthiban SRR. A Study to Evaluate Use of Platelet Indices in Hyperdestructive Thrombocytopenia: A Two-year Experience from Tertiary Care Rural Hospital. J Med Sci Health 2021;7(1):73-80.
15. Yalavarthi S, Halder NR, Pagidikalava A. Utility of platelet indices in diagnosing the underlying cause of thrombocytopenia due to accelerated platelet destruction. Ann Pathol Lab Med 2018;5:296-300.
16. Mala KG, Bhandari BJ, Kittur SK. Paramountcy of plateletparameters in thrombocytopenia our hospitalexperience. Indian J Pathol Oncol 2018;5:558-62.
17. Gulati I, Kumar H, Sheth J, Dey I. Diagnostic implication of mean platelet volume in thrombocytopenia. Med J DY Patil Univ 2017;10:370-5.
18. Zulfania Z, Hayat H, Mahmood R, Bukhari A, Ihtesham Y, Rasool U. Comparison of platelet indices in hypoproductive and hyperdestructive thrombocytopenia. PJP. 30 Jun.2021.
19. Elsewefy DA, Farweez BA, Ibrahim RR. Platelet indices: Consideration in thrombocytopenia. Egypt J Haematol 2014;39:134-9.
20. Borkataky S, Jain R, Gupta R, Singh S, Krishan G, Gupta K, et al. Role of platelet volume indices in the differential diagnosis of thrombocytopenia: A simple and inexpensive method. Hematology 2009;14:182-6.
21. Ntaios G, Papadopoulos A, Chatzinikolaou A, Saouli Z, Karalazou P, Kaiafa G, et al. Increased values of mean platelet volume and platelet size deviation width may provide a safe positive diagnosis of idiopathic thrombocytopenic purpura. Acta Haematol 2008;119:173-7.

22. Kaito K, Otsubo H, Usui N, Yoshida M, Tanno J, Kurihara E, et al. Platelet size deviation width, platelet large cell ratio, and mean platelet volume have sufficient sensitivity and specificity in the diagnosis of immune thrombocytopenia. Br J Haematol 2005;128:698-702.