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Etiology of Thrombocytopenia and Its Correlation with Platelet Indices: A Tertiary Care Hospital-Based Retrospective Study

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KEYWORDS

Leukemia, Thrombocytopenia, Hemophagocytic lymphohistocytosis, Hemorrhage, Platelet count

ABSTRACT:

Introduction: Thrombocytopenia results from either increased destruction or reduced production of platelets. Although bone marrow examination is the diagnostic gold standard, it is invasive, costly, and may cause bleeding. Therefore, it is not preferred as an initial test. Automated hematology analyzers now offer platelet indices that help identify the underlying cause non-invasively.

Objectives: To analyze the platelet parameters (Mean Platelet Volume, plateletcrit, Platelet Distribution Width) between hyperdestruction thrombocytopenia and hypoproduction thrombocytopenia, find the etiology of thrombocytopenia with clinical correlation, to compare the platelet indices with degrees of severity of thrombocytopenia and to analyze age and gender-wise distribution of thrombocytopenia.

Methods: This study was done in 92 thrombocytopenic patients after ethical approval. Participants for the study will be selected from patients undergoing investigations for hematological abnormalities Complete blood counts including platelet indices were analyzed using an automated hematology analyzer, and bone marrow examination findings were reviewed. Data were analyzed.

Results: Hypoproductive thrombocytopenia was more common (73.91%) than hyperdestructive (26.09%), with acute myeloid leukemia being the commonest cause. Males had a slight predominance, especially in the hyperdestructive group. The greatest burden of moderate to severe thrombocytopenia cases was observed in the 45–54 age group. Plateletcrit and platelet count were better markers of severity. Mean platelet volume and platelet distribution width were considerably greater in hyperdestructive thrombocytopenia but did not differ by severity.

Conclusions: Classification based on etiology is necessary for precise diagnosis and treatment. Bone marrow examination remains crucial, especially in unclear cases, as opposed to infection-related thrombocytopenia, where non-invasive tests may suffice.

1. Introduction

Platelets serve a crucial role in maintaining homeostasis, but they also play non-homeostatic roles in angiogenesis, tissue repair, and inflammation. [1] Normal peripheral blood count of platelets is within the range of 1,50,000 to 4,50,000/µL, and when it goes below 1,50,000/µL, we call it thrombocytopenia. [2] Usually, patients with platelet counts above 50,000/µL show no

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symptoms. Patients with platelet counts between 30,000 to 50,000/ µL may have significant bleeding after trauma, but they rarely present with purpura. [3] However, counts between 10,000–30,000/ µL may result in bleeding with minimal trauma, while values below 10,000/µL raise the possibility of spontaneous bleeding, petechiae, and bruises. [3] Evaluating whether hyperdestructive or inadequate production is the cause of low platelet count is essential for evaluating the condition. [1]

Hyperdestructive thrombocytopenia commonly results from immune thrombocytopenic purpura (ITP), secondary ITP, and disseminated intravascular coagulopathy (DIC). Reduced bone marrow production occurs due to primary or secondary bone marrow illness, including myelodysplastic syndrome, acute leukemia, aplastic anemia, megaloblastic anemia, and post-chemotherapy. [4] Over decades, bone marrow aspiration studies continued to be the most reliable method for determining thrombocytopenia etiology. However, there is a chance of bleeding during bone marrow procedure, and the technique is invasive and time-consuming. [5] With EDTA samples, platelet indices can be readily obtained in addition to platelet counts on an automated hematology analyzer, which helps in the early determination of the etiology of thrombocytopenia. This will help in the immediate treatment of thrombocytopenia, thereby preventing severe bleeding manifestations like intracranial hemorrhage. [6] These days, the automated blood cell analyzer uses a variety of machine-derived platelet indices to determine the reason for thrombocytopenia. Thus, this study is required to investigate and compare platelet indices in various types of thrombocytopenia, find underlying causes, assess their link with disease severity, and comprehend demographic distribution patterns. The findings may improve diagnostic accuracy and enhance clinical decision-making in patients with thrombocytopenia.

To distinguish between hypoproductive and hyperdestructive thrombocytopenia, platelet size is a helpful marker. The combined interpretation of the platelet (PLT) count and platelet indices like mean platelet volume (MPV), plateletcrit (PCT), and platelet distribution width (PDW), by automated cell counters can be useful in differentiating thrombocytopenias due to different causes. [7] This may help to some degree to prevent the diagnostic evaluation of thrombocytopenic patients using bone marrow aspiration as a method. [8] Since early diagnosis and treatment of thrombocytopenia can lower the morbidity and death rate of individuals with low platelet counts, platelet indices can play a major predictive role. [1]

2. Objectives

- To analyze the platelet parameters (Mean Platelet Volume, plateletcrit, Platelet Distribution Width) between hyperdestruction thrombocytopenia and hypoproduction thrombocytopenia
- To find the etiology of thrombocytopenia with clinical correlation.
- To compare the platelet indices with degrees of severity of thrombocytopenia.
- To analyze age and gender-wise distribution of thrombocytopenia.

3. Methods

A retrospective study was carried out on patients with thrombocytopenia, which was done at the central laboratory of a tertiary care hospital. After approval from the institutional scientific review board committee (SRB/MLT/02/2024), a waiver of consent was obtained from institutional Ethics Committee, and the participant data was collected from the period of 16 January 2023 to 15 January 2024.

SOURCE OF DATA SAMPLING METHOD

A total of 92 samples with platelet counts less than 1. 5 lakh/µL were collected by simple random sampling technique. CBC test and bone marrow study details were collected from the backbone (computerized records) of the central laboratory. Patients' clinical details were obtained from the medical records department.

PROCEDURE

EDTA anticoagulated bone marrow aspiration and trephine biopsy material was collected and analyzed by microscopic examination under 40x and 100x magnification and recorded findings were collected. Also, blood samples of patients were received in

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EDTA anticoagulated vacutainers, and it was analyzed using a 6-part SYSMEX XN-1000 fully automated haematology analyzer for platelet count and platelet indices, i.e., MPV, PDW, PCT. The correlation with the platelet indices and the determination of the impact of thrombocytopenia in a tertiary care hospital will be analysed by utilizing statistical analysis.

INCLUSION CRITERIA AND EXCLUSION CRITERIA

Thrombocytopenic patients of both genders who were admitted in IPD with age between 18 – 80 years old and who had undergone bone marrow aspiration and trephine biopsy were included in this study. Participants with coagulation disorder, pregnant women, neonates, patients on anti-platelet drugs, and drug-causing thrombocytopenia were excluded from the study.

STATISTICAL ANALYSIS

1.Descriptive statistics

•The continuous variables will be summarised using mean and standard deviation.

•The categorical variables will be summarised using frequency and percentage.

2.Independent t-test will be used to compare the platelet indices with the degree of severity of thrombocytopenia.

The data was analysed using SPSS software (SPSS Inc.; Chicago, IL) version 29.0.10.

4. Results

A retrospective study was conducted on 92 thrombocytopenic patients for a period of 1 year. The patients had been divided into two groups based on the pathogenesis of thrombocytopenia as: 68 cases of hypoproductive and 24 hyperdestructive cases (figure:1) with a mean of 47.41.

The most common age group affected by thrombocytopenia was aged between 45 to 54 years old (33.7%), followed by 55 to 64 years old (20.7%). Whereas the age group between 75-80 years old was least affected by thrombocytopenia. (figure 2)

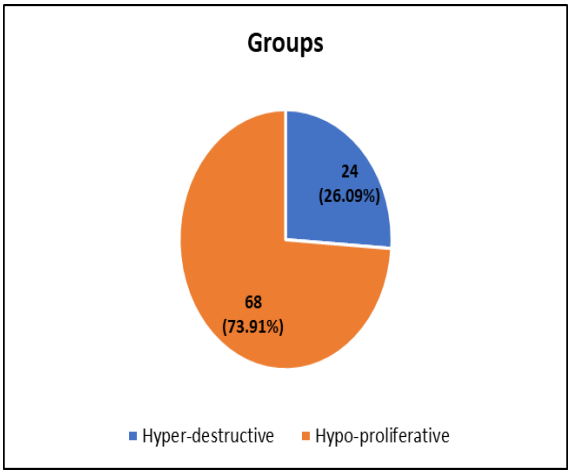

Figure 1: Graphical representation of groups distribution

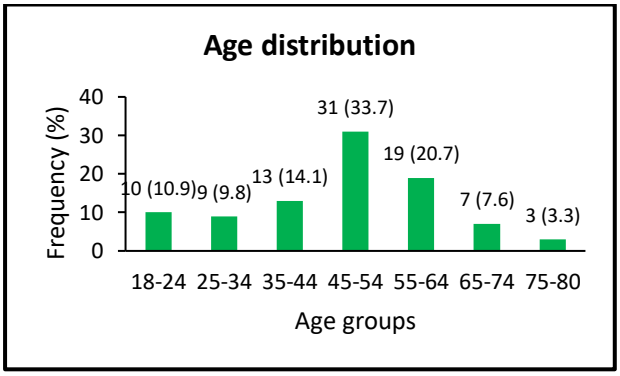

Figure 2: Graphical representation of age distribution

There were 52.2% (48 cases) males and 47.8% (44 cases) females, with a slight male predominance. (figure 3) And the male-to-female ratio was 1.09:1.

Gender distribution among groups

The chi-square test result (χ^2 = 4.53, p = 0.033) showed statistically significant association between gender and hyperdestructive and hypoproductive conditions at the standard significance level. The majority (84.1%) of females (n = 44) were classified as hypoproductive, with only 15.9% classified as hyperdestructive. Among males (n = 48) were more likely (35.4%) to be classed as hyperdestructive than females. (Table 1)

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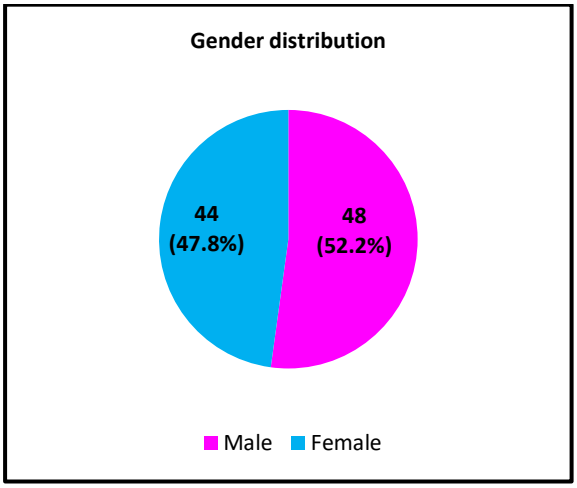

Figure 3: Graphical representation of gender distribution

Table 1: Gender distribution among groups

Gender	Group		Total	Test Statistic	p-value
	Hyperdestructive	Hypoproductive			
Female	7(15.9 %)	37(84.1 %)	44	4.53	**0.033**
Male	17(35.4 %)	31(64.6 %)	48		

Gender distribution among groups

The chi-square test result (χ^2 = 4.53, p = 0.033) showed statistically significant association between gender and hyperdestructive and hypoproductive conditions at the standard significance level. The majority (84.1%) of females (n = 44) were classified as hypoproductive, with only 15.9% classified as hyperdestructive. Among males (n = 48) were more likely (35.4%) to be classed as hyperdestructive than females. (Table 1)

Severity of thrombocytopenia

It's categorized into 3 grades based on platelet count. Platelet count in between 1,00,000–1,50,000/µL is considered as mild, followed by moderate (50,000–1,00,000/ µL) and severe (less than 50,000/ µL) thrombocytopenia respectively. In this study, the majority of the cases showed moderate thrombocytopenia (38%), followed by severe thrombocytopenia (37%) and then mild thrombocytopenia (25%). (figure: 4)

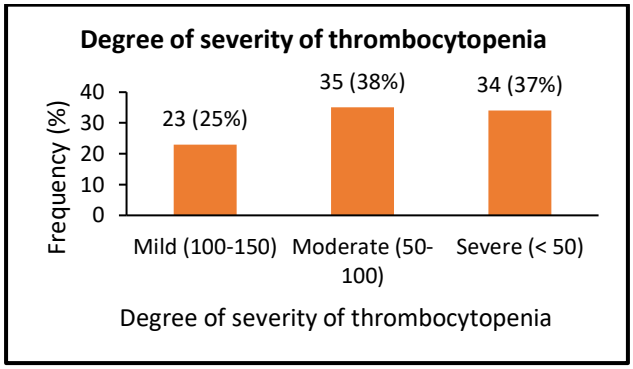

Figure 4: Graphical representation of Degree of severity of thrombocytopenia

Association of gender and age with degree of severity of thrombocytopenia

In gender-wise distribution according to the severity of thrombocytopenia, the highest frequency of moderate thrombocytopenia was more common in males (60%), while mild thrombocytopenia was slightly more common in females (56.5%), but severe thrombocytopenia was equally distributed in both genders. (Table 2).

Table 2: Association of gender and age with degree of severity of thrombocytopenia

		Degree of severity of thrombocytopenia						Chi square / Likelihood ratio#	p value
		Mild (100-150× 10^9/L)		Moderate (50-100× 10^9/L)		Severe (< 50× 10^9/L)			
		n	%	n	%	n	%		
Gender	Male	10	43.5	21	60.0	17	50.0	1.62	0.445
	Female	13	56.5	14	40.0	17	50.0		
Age groups	18-24	3	13.0	1	2.9	6	17.6	**21.32**	**0.046**
	25-34	2	8.7	7	20.0	0	0		
	35-44	3	13.0	6	17.1	4	11.8		
	45-54	6	26.1	13	37.1	12	35.3		
	55-64	6	26.1	3	8.6	10	29.4		
	65-74	2	8.7	4	11.4	1	2.9		
	75-80	1	4.3	1	2.9	1	2.9		

The severity of thrombocytopenia across different age groups showed that the age group between 45-54 years had the highest frequency of moderate thrombocytopenia (37.1%), followed by 25-34 years (20%) and 35-44 years (17.1%). The highest frequency of severe thrombocytopenia was found in

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the age group between 45-54 years (35.3%), followed by 29.4% in 55-64 years and 17.6% in the age group of 18-24 years. The highest frequency of mild thrombocytopenia was seen in the age group between 45-54 and 55-64 years (26.1% each), followed by the age group between 18-24 and 35-44 years (13% each). Younger age groups of 18–24 and 25–34 years generally had lower frequencies of mild thrombocytopenia, whereas older age groups between 75–80 age group had the lowest frequencies across all severity levels. The chi-square test was used to find the association of gender and age with the degree of severity of thrombocytopenia. A significant correlation ($p < 0.05$) was found in between the age and degree of severity of thrombocytopenia. (Table 2)

Etiology of thrombocytopenia

Acute myeloid leukemia (AML) was the most common etiology for thrombocytopenia, accounting for 25% of the cases. Hemophagocytic lymphohistocytosis (HLH) and fungal infections were the second most frequent causes, each contributing to 6.52%, respectively. Several other etiologies, including acute lymphoblastic leukemia (ALL), megaloblastic anemia, klebsiella pneumonia, portal hypertension, and sepsis, each accounted for 5.43% of cases, respectively. Notably, hepatitis B and non-Hodgkin lymphoma (NHL) were identified in 4.34% of cases, while carcinoma, chronic myeloid leukemia (CML), immune thrombocytopenic purpura (ITP), and multiple myeloma each constituted 3.26%. Less common causes included acute kidney injury (AKI), myelodysplastic syndromes (MDS), autoimmune diseases, and a range of rare conditions such as cirrhosis, chronic lymphocytic leukemia (CLL), dengue, HIV, and drug-induced thrombocytopenia (methotrexate), each contributing around 1.08% individually.

Among hyperdestructive group CKD was most common, followed by fungal infection, sepsis and ITP cases respectively (Table 3).

Among hypoproductive group AMLwas most common, followed by HLH, ALL, megaloblastic anaemia, klebsiella pneumonia, and portal hypertension (7.35% cases each respectively) (Table 4).

Table 3: Etiology of thrombocytopenia among hyperdestructive thrombocytopenia

Etiology	frequency	percentage
CKD	7	29.16
fungal infection	6	25.0
sepsis	5	20.83
ITP	3	12.5
AKI	2	8.33
autoimmune disease	2	8.33
TTP	1	4.16
HIV	1	4.16
dengue	1	4.16

Table 4: Etiology of thrombocytopenia among hypoproductive thrombocytopenia

Etiology	frequency	percentage
Acute myeloid leukemia	23	35.29
Hemophagocytic lymphohistocytosis	6	8.82
Acute lymphoid leukemia	5	7.35
Megaloblastic anemia	5	7.35
Klebsiella pneumonia	5	7.35
Portal hypertension	5	7.35
Non-Hodgkin lymphoma	4	5.88

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Hepatitis B	4	5.88
Carcinoma (cervix, breast)	3	4.41
Multiple myeloma	3	4.41
Chronic myeloid leukemia	3	4.41
Myelodysplastic syndrome	2	2.94
Chronic lymphoid leukemia	1	1.47
Extra hepatic portal vein thrombosis	1	1.47
Aplastic anemia	1	1.47
Cirrhosis	1	1.47
Myelofibrosis	1	1.47
Methotrexate induced	1	1.47
Tuberculosis	1	1.47

Clinical features of thrombocytopenia

The most common clinical features of thrombocytopenia were generalized weakness (63.0%), fever (35.9%), and bleeding manifestations (22.8%). Symptoms like pallor, chills and cough were less common (Table 5).

Table 5: Clinical features of thrombocytopenia

Clinical features	Frequency	Percentage
Generalized weakness	58	63.0
Fever	33	35.9
Bleeding manifestation	21	22.8
Chills and rigor	13	14.1
Pallor	11	12.0
Cough	9	9.8
Breathlessness	8	8.7
Nausea and Vomiting	8	8.6
Body pain	8	8.6
Abdominal pain	7	7.6
Decreased appetite	6	6.5
Weight loss	5	5.4
Lower limb swelling	5	5.4
Burning micturition	3	3.3
Palpitation	2	2.2
Seizure	2	2.2
Erythematous skin rash	2	2.2

Bleeding was more common in hypoproductive thrombocytopenia; oral bleeding and haematuria were predominant types. (Table 6)

Table 6: Assessment of bleeding manifestation associated with thrombocytopenia

Bleeding manifestation associated with thrombocytopenia	Groups				Total
	Hyper destructive		Hypo productive		percentage
	n	%	n	%	%
Blood in stool	1	11.1	0	0	4.7
Cerebellar haemorrhage	1	11.1	0	0	4.7
Ecchymosis	1	11.1	0	0	4.7
Epistaxis	1	11.1	0	0	4.7
Eye haemorrhage	0	0	1	8.3	4.7

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Haemorrhagic stroke	0	0	1	8.3	4.7
Hematemesis	1	11.1	2	10.5	**14.2**
Haematochezia	0	0	1	8.3	4.7
Haematuria	2	22.2	1	8.3	**14.2**
Mucosal bleeding	0	0	2	10.5	9.5
Oral bleeding	0	0	3	25	**14.2**
Upper GI bleeding	1	11.1	1	8.3	9.5
Petechiae	1	11.1	0	0	4.7

Distribution of cases based on different levels of platelet parameters

On comparison of platelet indices (MPV, PDW, and PCT) between the groups were categorized as decreased, normal, or increased. Most patients had normal MPV (65.2%) and PDW (71.7%), while PCT was decreased in the majority (81.5%). No patients showed decreased MPV. (Table 7)

Table 7: Distribution of cases based on different levels of platelet parameters

Platelet parameters	Different levels	Frequency	%
MPV	Decreased than the normal level	0	0
	Within the normal level	**60**	**65.2**
	Increased than the normal level	32	34.7
PDW	Decreased than the normal level	16	17.3
	Within the normal level	**66**	**71.7**
	Increased than the normal level	10	10.8
PCT	Decreased than the normal level	**75**	**81.5**
	Within the normal level	15	16.3
	Increased than the normal level	2	2.1

Comparison of platelet count and platelet indices in between hyperdestructive and hypoproductive groups:

Independent sample t test (Student t test) was utilised to compare the platelet count and PCT, however there was no statistically significant difference in platelet count ($p = 0.251$) and PCT ($p = 0.229$) between the hyperdestructive and hypoproductive groups. The Independent sample t test (Welch t test, Student t test) done to compare the platelet count with PDW and MPV showed significant difference in PDW and MPV ($p = <.001$) between the hyperdestructive and hypoproductive groups. (Table 8)

Table 8: Comparison of platelet count and indices between hyperdestructive & hypoproductive groups

Platelet parameters	Different levels	Frequency	percentage
MPV	Decreased than the normal level	0	0
	Within the normal level	60	65.2
	Increased than the normal level	32	34.7
PDW	Decreased than the normal level	16	17.3
	Within the	66	71.7

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	normal level		
	Increased than the normal level	10	10.8
PCT	Decreased than the normal level	75	81.5
	Within the normal level	15	16.3
	Increased than the normal level	2	2.1

Footnote: (% percentage)

Comparison of platelet indices levels between hyperdestructive and hypoproductive groups:

The chi-square test is used to find the association between MPV, PDW levels and thrombocytopenia types (hyperdestructive vs. hypoproductive).

Table 9: Comparison of platelet count and indices between hyperdestructive & hypoproductive groups

Platelet Indices	Platelet Parameter Grades	Group		Test Statistic	p-value
		Hyper destructive	Hypo productive		
MPV	Normal	2(3.3 %)	58(96.7 %)	46.3	< 0.001
	Increased	22(68.8 %)	10(31.3 %)		
PDW	Normal	13(19.7 %)	53(80.3 %)	16.9	< 0.001
	Increased	8(80.0 %)	2(20.0 %)		
	Decreased	3(18.8 %)	13(81.3 %)		
PCT	Normal	4(26.7 %)	11(73.3 %)	-	0.639
	Increased	1(50.0 %)	1(50.0 %)	-	
	Decreased	19(25.3 %)	56(74.7 %)		

Among patients in the hyperdestructive group, 68.8% showed increased MPV, compared to 31.3% in the hypoproductive group. Conversely, 96.7% of patients in the hypoproductive group had normal MPV values, while only 3.3% in the hyperdestructive group had normal MPV. The difference was highly significant ($\chi^2 = 46.3$, $p < 0.001$). Similarly, PDW was increased in 80.0% of the hyperdestructive group, whereas only 20.0% of the hypoproductive group exhibited increased PDW. Normal PDW values were observed predominantly in the hypoproductive group (81.3%) compared to the hyperdestructive group (18.8%). This difference was also statistically significant ($\chi^2 = 16.9$, $p < 0.001$) indicating significant association between both MPV and PDW levels and the type of thrombocytopenia. The association between PCT levels and the types of thrombocytopenia was analyzed using Fisher's exact test, which showed a p-value of 0.639, which is greater than the standard significance level. This indicates that there is no significant association between PCT levels and the type of thrombocytopenia. (Table 9)

Table 10: Comparison of platelet counts and platelet indices with degree of severity of thrombocytopenia

Variables	Degree of Severity	Mean	Median	SD	Test Statistic	p-value
T. Platelet count	MILD	103.261	113	40.5308	19.7	<0.001
	MODERATE	74.6286	70	15.0139		
	SEVERE	38.8824	28	38.4217		
MPV	MILD	11.1435	10.6	2.0349	0.5283	0.591
	MODERATE	10.7629	10.5	1.5176		
	SEVERE	10.6765	10.7	1.755		
PCT	MILD	0.0987	0.11	0.0478	10.8	<0.001
	MODERATE	0.1031	0.07	0.1058		
	SEVERE	0.0441	0.03	0.0472		
PDW	MILD	12.3478	11.5	4.4375	0.0735	0.929
	MODERATE	12.6229	12.4	3.5583		
	SEVERE	12.3	12.15	3.3268		

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Comparison of platelet counts and platelet indices with degree of severity of thrombocytopenia analysis showed significant differences in total platelet count and PCT across the severity of thrombocytopenia, with Welch ANOVA resulted in a p-value of < 0.001 and was considered statistically significant. The Fisher's Exact Test (One-way Anova) was used to find the association between MPV and PDW across the severity of thrombocytopenia. However, no significant differences were observed in MPV ($p = 0.591$) and PDW ($p = 0.929$), indicating that these parameters remain consistent across thrombocytopenia severity levels. (Table 10)

5. Discussion

There is a scarcity of literature on thrombocytopenia, which is a common condition seen in clinics. Especially in countries like India, cases rise quickly during monsoons, sometimes causing serious bleeding. Therefore, conduct region-specific and seasonal studies to better understand the changing patterns and causes of thrombocytopenia, especially during monsoons. [9]

In this study, we studied three platelet parameters, i.e., MPV, PDW, and PCT, in thrombocytopenic cases who underwent bone marrow study and to interpret their importance.

Group Distribution:

Based on bone marrow examination, 92 patients were classified into hypoproductive (73.9%) and hyperdestructive (26.1%) thrombocytopenia groups. This predominance of hypoproductive cases aligns with findings by Parveen S et al. (78.3%) [17] and other studies. [5,20,21,29,30]

Age Distribution:

Thrombocytopenia was most common in the 45–54 years age group (33.7%), followed by 55–64 years (20.7%). The least affected group was aged 75–80 years. Similar age trends were reported by Choudhary M et al. and Vimal M et al., with peak incidences in middle-aged adults. [15,16]

Gender Distribution:

In the hyperdestructive group, males (35.4%) outnumbered females (15.9%), whereas females predominated in the hypoproductive group (84.1%). A comparable gender pattern was reported by Peddaverannagari T et al. [13]

Severity of Thrombocytopenia:

Moderate thrombocytopenia was the most frequent (54%), followed by severe (32%) and mild (14%), consistent with results from Shankarappa RS et al. and Vimal M et al. [15,18]

Association of Gender and Age with Severity:

Moderate thrombocytopenia was more common in males (60%), while mild thrombocytopenia was slightly higher in females (56.5%). Severe thrombocytopenia was equally distributed (50%). Saber et al. also reported no significant gender-based differences. [19] Moderate and severe thrombocytopenia were most prevalent in the 45–54 age group, with lower frequencies in younger (18–34) and elderly (75–80) age groups. These trends differed from Gamit M et al. [9]

Etiology of thrombocytopenia:

The most common etiology of thrombocytopenia was acute myeloid leukemia (AML) (25%), highlighting a significant association between hematological malignancies and thrombocytopenia. Hemophagocytic lymphohistiocytosis and fungal infections were the next most frequent causes (6.52% each), followed by ALL, megaloblastic anemia, klebsiella pneumonia, portal hypertension, and sepsis (5.43% each). Less frequent causes included hepatitis B, non-Hodgkin lymphoma (NHL), carcinoma, chronic myeloid leukemia (CML), ITP, and multiple myeloma. These findings are comparable to those of Muhury M et al., who also reported AML (18.8%) as the leading cause of thrombocytopenia. [20]

Delavigne K et al. further reported that 9.3% of AML patients developed HLH, often with concurrent fungal infections and severe thrombocytopenia, leading to poorer outcomes. [23] This indicates that AML patients have a higher risk of developing HLH, fungal infection, and thrombocytopenia, similar to the findings seen in our study.

Contrastingly, few studies identified dengue and malaria as the most common etiologies, typically

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self-limiting and diagnosed via CBC and peripheral smear. [9,10,11] In such cases, advanced diagnostics like bone marrow biopsy may not be required. [22] However, our study emphasizes the importance of bone marrow evaluation for definitive diagnosis, particularly in cases suggestive of marrow pathology.

Among hyperdestructive causes, chronic kidney disease (CKD) (29.16%), fungal infections (25%), sepsis (20.83%), and ITP (12.5%) were most common. Vara Prasad BM et al. also reported sepsis, renal disease, ITP, and liver disease as frequent hyperdestructive causes. [25] In the hypoproductive category, Zulfania et al. and Norrasethada L et al., also reported similar outcome with AML being a leading cause of hypoproductive thrombocytopenia. [12,24]

Clinical Features:

Similar to present study Choudhary M et al., reported generalized weakness (70%), hemorrhagic manifestations (60%), and fever (50%) as the most prevalent symptoms. [16] Another study by, Vimal M et al. noted fever (45%) and bleeding manifestations (13.3%) as leading presentations, along with other nonspecific complaints. [15]

Bleeding Manifestations:

Among the 92 patients, 21 (22.8%) presented with bleeding symptoms. The most frequent types were haematuria, oral bleeding, and hematemesis (3.3% each), followed by mucosal and upper gastrointestinal bleeding (2.2%). Patne SV et al. observed a higher bleeding incidence (37.5%), most commonly from skin and mucous membranes (40%), gums (13.3%), and less frequently hematemesis (6.6%) and haematuria (4.5%). [11]

Platelet Indices:

On comparison of platelet indices grades between hypo destructive and hypo proliferative groups similar result was reported by Saran K et al., with elevated MPV and PDW in hyperdestructive thrombocytopenia and reduced MPV and PCT in hypoproductive cases. [10]

On comparison of platelet indices between the groups, Saran K et al., who also observed increased MPV in hyperdestructive and decreased MPV and PCT in hypoproductive thrombocytopenia, with elevated PDW in both groups. [10] Khan MJ et al. similarly reported no significant difference in PCT between the two groups. [26] According to Parka Y et al., PCT reflects the platelet volume percentage and varies with the severity of thrombocytopenia, irrespective of its cause. [27] Nonetheless, PCT may still be valuable as a screening tool for quantitative platelet disorders due to its correlation with platelet count.[1]

Platelet parameters and severity:

In our study, total platelet counts and PCT showed a statistically significant association with the severity of thrombocytopenia ($p < 0.001$). Similar findings were reported in a study done by Bhattacharyya A et al. [14] Mittal et al. also found no significant variation in MPV, PCT, or PLCR across severity grades, with mean PCT values decreasing with increasing severity. [1] Chandrashekhar V et al. emphasized the utility of PCT in identifying quantitative platelet abnormalities and guiding transfusion needs, noting that not all thrombocytopenic patients require platelet transfusion. [28, 1]

The study concluded that hypoproductive thrombocytopenia is more common than hyperdestructive thrombocytopenia, with acute myeloid leukemia being the leading cause. Hyperdestructive thrombocytopenia was primarily linked to chronic kidney disease, fungal infections, and sepsis. Symptoms like generalised weakness and fever were more prevalent in hypoproductive patients, who also had more recurrent bleeding episodes. This highlights the significance of etiology-based differentiation in diagnosis and management, as the cause and clinical characteristics differ significantly between the two groups. Also, the study highlights that acute myeloid leukemia patients undergoing chemotherapy may have a high risk of HLH and severe infections, including fungal infections, so it is essential to make necessary evaluations for early diagnosis recognition and proactive management of HLH in AML patients, particularly in those presenting with

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thrombocytopenias and infection-related complications.

Furthermore, there was a small gender predominance, with males more likely to present with hyperdestructive thrombocytopenia. Age group in between 45-54 years old had a significant frequency of moderate and severe cases, emphasizing the importance of targeted examination in this age group. Among the numerous platelet indices associated with thrombocytopenia, MPV and PDW were significantly elevated in hyperdestructive thrombocytopenia, indicating their utility for use as disease burden markers. In contrast, MPV and PDW did not significantly differ across severity grades, indicating that they are more helpful in categorizing the type of thrombocytopenia rather than assessing its severity. Therefore, PCT and platelet count may serve as a useful biomarker in determining severity. Here, platelet function tests were not used to determine how well platelets operate. This limits our ability to properly understand the bleeding risk in patients with mild to moderate thrombocytopenia cases who presented with severe bleeding manifestations.

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