Hematological Manifestations of Malaria and Their Diagnostic Significance

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Conflict of interest: Nil

Abstract

Background: Malaria is a protozoal disease spread by bite of infected anopheles mosquito. It is caused by species of genus plasmodium i.e. *P. vivax, P. falciparum, P. ovale* & *P. malariae*. It is one of the important parasitic diseases of human presenting with fever, chills with rigor, malaise, headache, myalgia, anorexia, vomiting, anemia & enlarged spleen.

Materials and Methods: This two-year prospective study involved 150 confirmed malaria patients over 10 years old, assessed with clinical exams and hematological tests (CBC, RBC indices, platelet parameters) using automated analyzers.

Results: This study of 150 confirmed malaria cases in India revealed that Plasmodium vivax was the most prevalent species (68.6%), followed by P. falciparum (20.6%) and mixed infections (10.6%). The study highlighted significant hematological complications, including anemia (94% of cases), thrombocytopenia (84.6%), and altered RBC and platelet indices.

Discussion: Anemia and thrombocytopenia are prevalent hematological complications in malaria, with notable reductions in hemoglobin, RBC count, hematocrit, platelet count, and plateletcrit. The findings emphasize the importance of hematological parameters in diagnosing and monitoring malaria, particularly in endemic regions.

Keywords: Malaria, Plasmodium vivax, Plasmodium falcifarum.

Introduction

Malaria is a serious protozoal disease caused by Plasmodium species (*P. vivax, P. falciparum, P. ovale,* and *P. malariae*) and transmitted by the bite of an infected Anopheles mosquito [1].

Despite global efforts, malaria remains a widespread health issue, with about half the world's population at risk, particularly in developing countries like India.

In India, malaria is highly prevalent in certain states, although the Annual Parasite Incidence (API) has been steadily declining. The disease commonly presents with fever, chills, and other flu-like symptoms, but severe cases can involve organ failure and neurological issues.

Diagnosis relies on clinical signs and various laboratory tests. Malaria often causes hematological abnormalities such as anemia, thrombocytopenia, and splenomegaly, with changes influenced by factors like endemicity, nutrition, and immunity. This study focuses on examining the hematological impacts of acute malaria.

Material and methods

This prospective longitudinal study was conducted over a period of two years at the Department of Pathology, MLB Medical College, Jhansi, involving 150 confirmed malaria patients (by peripheral smear or Quantitative Buffy Coat). Patients above 10 years with fever under one week and positive for malaria were included, while those with negative smears, other infections, chronic diseases, or hematological malignancies were excluded. Detailed clinical assessments and comprehensive hematological investigations (CBC, RBC indices, platelet parameters etc.) were conducted using an automated hematology analyzer. Diagnostic methods included thick/thin smears, QBC, and Leishman staining.

Results

Table 1: Incidence of Malarial Infection

Malarial parasite	No. of Patients
Plasmodium Vivax	103
Plasmodium falcifarum	31
Mixed	16

In our study of 150 patients Plasmodium vivax is the predominant infection in malaria.
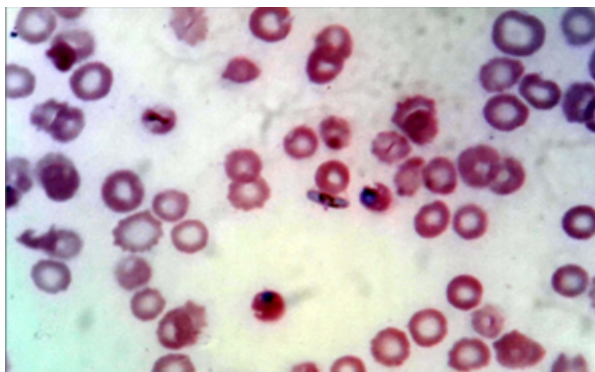
Figure 1: *P. falcifarum* gametocyte and ring stage in peripheral blood (Leishman 100x)
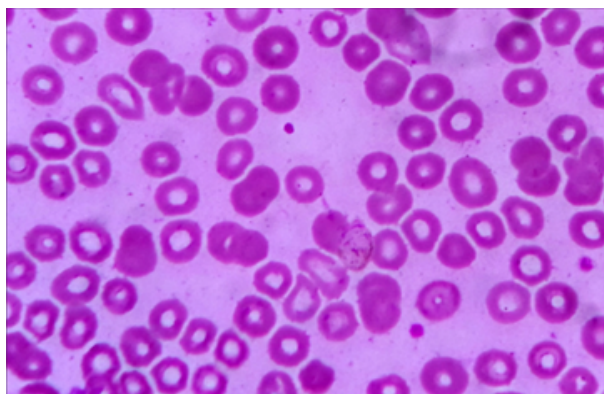
Figure 2: *P. vivax* gametocyte in peripheral blood (Leishman 100x)

Table 2: Distribution of Malaria According To Sex

Malarial parasite	Male	Female	Total
P. Vivax	68	35	103
P.falcifarum	20	11	31
Mixed	09	07	16
Total	97	53	150

Table 3: Malaria Affecting Different Age Groups

Age (years)	*P. Vivax*	*P. Falcifarum*	Mixed	Total
11-20	11	02	02	15
21-30	37	11	06	54
31-40	30	12	03	43
41-50	12	03	05	22
>50	13	03	00	16

Table 4: Effect of Malaria on Hemoglobin, RBC Count & Hematocrit

Hb (at time of admission) in g/dl	<8	8-10.9	11-12.9	>13
No of patients	51	63	28	08
RBC count (at time of admission) in millions/cumm	**<2**	**2-4**	**>4**	**-**
No of patients	35	89	26	-
Hematocrit (at time of admission) in %	**<20**	**20-40**	**>40**	**-**
No of patients	38	105	07	-

Table 5: Effect of Malaria on RBC Indices

Mean Corpuscular Volume, MCV (fl)	<76	76-96	>96
No of patients	13	74	63
Mean Corpuscular Hemoglobin MCH (pg)	<27	27-32	>32
No of patients	44	66	40
Mean Corpuscular Hemoglobin Concentration MCHC (g/dl)	<30	30-35	>35
No of patients	25	109	16
Red Cell Distribution Width RDW (%)	<11	11-16	>16
No of patients	0	17	133

Table 6: Effect of Malaria on White Blood Cells Count

WBC (at time of admission) /cumm	<4000	4000-11000	>11000
No of patients	41	97	12

Table 7: Effect of Malaria on Platelet Count

Platelet count (at time of admission) x10^3 /cumm	<150	150-450	>450
No of patients	127	23	0

Table 8: Effect of Malaria on Platelet Indices

Platelet Distribution Width PDW (%)	<9	9-17	>17
No of patients	0	76	74
Mean Platelet Volume MPV (fl)	<9	9-13	>13
No of patients	12	106	32
Plateletcrit PCT (%)	<0.19	0.19-0.4	>0.4
No of patients	121	27	02

Discussion

Malaria remains a persistent public health challenge in tropical regions, particularly in India, which contributes significantly to the global malaria burden. In 2022, India accounted for approximately 66% of malaria cases in the WHO South-East Asia Region, with nearly all reported cases due to Plasmodium falciparum and Plasmodium vivax [1]. Despite substantial progress in malaria control, the disease continues to place a significant strain on India's healthcare system [2]. Historically, P. vivax has been the dominant species in India, accounting for around 53% of cases, although a gradual shift toward a higher proportion of P. falciparum has been observed in recent years [3].

In our study of 150 confirmed malaria cases, P. vivax was the most prevalent species, observed in 68.6% of patients, followed by P. falciparum (20.6%) and mixed infections (10.6%). These findings are consistent with reports from northern and central India, such as in Bareilly, where P. vivax constituted over 86% of cases [4].

A male predominance was observed (64.6%), which likely reflects increased occupational exposure to vector habitats. The highest incidence was recorded in the 21–40 years age group (65%), aligning with the epidemiological profile reported in other regional studies [4]. Adult males, especially in endemic and peri-urban areas, are more frequently exposed to mosquitoes due to outdoor work, as also noted by Pathak et al. [10].

Hematological abnormalities were common. Anemia was the most frequently encountered abnormality, seen in 94% of patients, primarily of the normocytic normochromic type, suggestive of hemolysis and impaired erythropoiesis. RBC counts were decreased in 83%, and hematocrit was reduced in 95.5%, in agreement with findings from both adult and pediatric cohorts across India [6,11]. Similar patterns have been reported in complicated P. falciparum and P. vivax infections, indicating significant erythrocyte destruction and bone marrow suppression [8,12].

Thrombocytopenia was found in 84.6% of cases, underscoring its diagnostic and prognostic value in malaria. Several Indian studies have reported comparable findings, with prevalence rates ranging from 73% to over 90% [4,5,7]. Kochar et al. [6] and Dubey et al. [7] also documented thrombocytopenia across both species, suggesting that platelet reduction is not exclusive to P. falciparum. Despite low platelet counts, bleeding complications were rare, likely due to preserved platelet function and compensatory mechanisms. Immune-mediated destruction, splenic pooling, and decreased production are among the proposed mechanisms, and in severe cases, disseminated intravascular coagulation (DIC) may contribute [5,12,13]. White blood cell (WBC) abnormalities were less common. While 64.6% of patients had normal counts, leucopenia and leucocytosis were seen in 27% and 8% of cases, respectively. Leucopenia was more frequently associated with P. falciparum infections. Similar hematologic profiles

have been described in prior studies, where leucopenia is attributed to marginalization of WBCs or bone marrow suppression [2,10].

Red blood cell indices revealed variable changes. Mean corpuscular volume (MCV) was elevated in 42% of patients, though this did not correlate with megaloblastic anemia, as serum vitamin B_{12} levels remained normal. Mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were reduced in 29% and 17% of cases, respectively, reflecting subtle erythrocyte morphological alterations during infection. These findings echo the results from Kolkata and Andhra Pradesh, where anemia and RBC index variations were common in severe P. vivax malaria [8,10].

Alterations in platelet indices—often overlooked—were also noted. Plateletcrit (PCT) was reduced in 80% of patients, indicating a decline in total platelet mass. Platelet distribution width (PDW) was elevated in 49.3%, likely reflecting increased variability in platelet production and destruction. Mean platelet volume (MPV) was elevated in 21.3% of patients. These changes align with the findings of Sharma et al., who identified MPV and PDW as useful diagnostic indicators for malaria [9]. Gupta et al. further emphasized that reduced PCT and platelet count can serve as markers of disease severity [4]. Similar platelet functional alterations have also been described in studies from outside India, including reduced aggregation and secretion capacity in P. vivax malaria [14].

Conclusion

Anemia and thrombocytopenia are the most common hematological complications in malaria. Significant reductions in hemoglobin, RBC count, hematocrit, platelet count, and plateletcrit were observed, with increases in MPV and PDW. Most patients had normal WBC counts, with occasional leucopenia. Hematological parameters can aid in early diagnosis and monitoring of malaria.

References

1. World Health Organization. World malaria report 2023. Geneva: World Health Organization; 2023.
2. Kumar A, Valecha N, Jain T, Dash AP. Burden of malaria in India: retrospective and prospective view. Am J Trop Med Hyg. 2007; 77(6 Suppl):69–78.
3. Bharti PK, Chand SK, Singh MP, Mishra S, Shukla MM, Singh N. Emergence of a new focus of Plasmodium falciparum in central India. Acta Trop. 2014; 130:74–9.
4. Gupta M, Bansal D, Saini S. A cross-sectional study of thrombocytopenia in malaria positive cases in a tertiary care hospital of Bareilly, India. Int J Community Med Public Health. 2019; 6(6):2525–30.
5. Jadhav UM, Patkar VS, Kadam NN. Thrombocytopenia in malaria—correlation with type and severity of malaria. J Assoc Physicians India. 2004; 52:615–8.
6. Kochar DK, Das A, Kochar SK, et al. Severe Plasmodium vivax malaria: a report on serial cases from Bikaner in northwestern India. Am J Trop Med Hyg. 2009; 80(2):194–8.
7. Dubey A, Patidar RK, Dubey P. Significance of thrombocytopenia in different types of malaria: a tertiary care study from central India. Int J Med Res Rev. 2016; 4(9):1616–20.
8. Sarkar S, Saha K, Das CS. Clinico-laboratory profile of severe Plasmodium vivax malaria in a tertiary care centre in Kolkata. J Vector Borne Dis. 2013; 50(4):258–62.
9. Sharma A, Rawat D, Gautam S, et al. Diagnostic utility of platelet indices in malaria: an observational study from Uttarakhand, India. J Clin Diagn Res. 2017; 11(3):BC05–BC08.
10. Pathak S, Sharma S, Shrivastava D, Wankhade AB, Chourasiya S. Study of clinical profile of malaria in a tertiary care teaching hospital of central India. Int J Med Res Rev. 2016; 4(5):750–756.
11. Kochar DK, Tanwar GS, Khatri PC, et al. Clinical features of children hospitalized with malaria–a study from Bikaner, Northwest India. Am J Trop Med Hyg. 2010; 83(5):981–9.
12. Mishra SK, Mohanty S, Mohanty A. Hematological and coagulation profile in complicated falciparum malaria. J Assoc Physicians India. 2006; 54:301–6.
13. Kumar A, Shashirekha CA. Thrombocytopenia–an indicator of acute vivax malaria. Indian J Pathol Microbiol. 2006; 49(4):505–8.
14. Santos FMS, Leal-Santos FA, Reyes-Lecca RC, et al. Alterations of platelet function in uncomplicated Plasmodium vivax malaria. Acta Trop. 2012; 123(3):196–200.