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Original Research Article

Hematological Profile in Patients with Malaria: A Hospital-Based Observational Prospective Study

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Abstract

Background: Malaria is one of the leading causes of morbidity and death in endemic countries, and it has significant hematological modifications that point to clinical outcomes. Hemoglobin, leukocyte, platelet counts, and hematocrit are deranged in common during malarial infections and reflect severity of illness and prognosis. Comprehension of these changes is therefore important for early detection, follow-up, and intervention in treatment.

Methods: It was an observational study to be conducted prospectively for 12 months in a higher care hospital. 200 patients with definite malaria (peripheral smear and rapid antigen test) were included. Hematologic parameters such as hemoglobin (Hb), total leukocyte count (TLC), count of platelets, hematocrit, and differential counts were examined. Patients were stratified by the infective organism (Plasmodium falciparum, P. vivax, and mixed) and by severity. It was analyzed statistically by SPSS version 25.

Results: Of the 200 patients, 120 (60%) had P. vivax, 60 (30%) had P. falciparum, and 20 (10%) had mixed infections. Anemia (Hb <10 g/dL) was seen in 45% of patients, thrombocytopenia (<150 ×10⁹/L) in 72%, and leukopenia (<4 ×10⁹/L) in 28%. Severe thrombocytopenia (<50 ×10⁹/L) was much more frequent in P. falciparum (40%) than in P. vivax (15%) ($p < 0.05$).

Conclusion: Malaria is accompanied by common hematologic findings of anemia and thrombocytopenia, more pronounced in P. falciparum infections and mixed infections. Hematologic profiling can be done routinely to allow early identification of cases, disease severity prognosis, and appropriate care for patients living in endemic areas.

Keywords: Malaria, Hematology, Thrombocytopenia, Anemia, Plasmodium falciparum, Plasmodium vivax.

Introduction

Malaria is a vector-borne parasitic disorder that is brought on by the Plasmodium species and is acquired by human beings by bite of Anopheles mosquitoes that are infected. Though the methods of control have been perfected over the years, even today the disease fails to stop being the leading public health concern mostly in tropical and subtropical regions. An estimate of 249 million cases of malaria took place all over the world during the year 2022 as per the World Health Organization (WHO), and it proceeded to kill 608,000 individuals roughly, with the African region and South-East Asia becoming worst affected [1].

Malaria has severe haematologic effects. Infective parasite invasion of red blood cells (RBCs), immunologically mediated destruction of erythrocytes, and dyserythropoiesis are the causes of anaemia. Similarly, peripheral destruction, bone marrow suppression, and splenic sequestration are responsible for thrombocytopenia and leucocyte aberrations [2,3]. These haematologic derangements become important diagnostic and prognostic indicators. Anemia is one of the commonest of the disease of malaria's complications and the leading cause of death, primarily in children and in pregnant women [4].

Anemia is diagnosed by parasite species, parasite load, nutrition, and immunity of the host, actually. Thrombocytopenia, less deadly by comparison to anemia, is another frequent of the patients with malaria's hematologic abnormalities and is currently recognized to be an excellent predictor of early clinical disease of malaria suspicion in countries endemic for the disease [5]. Malaria leukocyte variations are less accurate, ranging from leukopenia to leukocytosis, and are more likely to reflect signs of defense reactions from the host than

parasite activities per se. Differential leukocyte examinations can reveal lymphopenia, monocytosis, or neutrophilia depending upon disease severity [6].

Species-specific differences in abnormal hematology have been documented. P. falciparum, through association with high parasitemia and severe illness, typically produces severe anemia and thrombocytopenia. However, P. vivax, previously considered to be benign, is increasingly recognized for the potential to produce severe morbidity with various complications of the hematologic type [7]. Mixed infections may exacerbate these derangements to give severe clinical cases.

Although the hematological findings of malaria are relatively well known, the pattern and intensity may vary from region to region within a geographic area, depending on endemicity, transmission intensity, and host genetic makeup [8]. Regional investigations are therefore mandatory for establishing region-specific hematological profiles for guiding clinical practice.

In order to evaluate the parameters of patients with malaria attending at a teaching hospital, to compare results for P. falciparum, P. vivax, and mixed infections, and to correlate the parameters with the severity of the disease.

Materials and Methods

Study Design and Setting: An observational prospective study was performed at the Department of Pathology, a Medical College Hospital, in a region of endemicity for malaria, located in Central India.

Study Population: A total of 200 consecutive patients aged ≥12 years presenting with febrile illness and diagnosed with malaria were included. Diagnosis was confirmed by peripheral blood smear (thick and thin smears stained with Giemsa) and rapid diagnostic tests (RDTs) for P. falciparum and P. vivax.

Inclusion Criteria

- Patients with laboratory-confirmed malaria (any species).
- Both genders, age ≥12 years.

Exclusion Criteria

- Patients with concurrent infections (e.g., dengue, typhoid, HIV).
- Patients with pre-existing hematological disorders or chronic illnesses affecting blood counts.
- Pregnant women (excluded to avoid confounding hematological effects).

Data Collection

Demographic data (age, sex, and residence), clinical features, and laboratory results were recorded. Hematological parameters analyzed included:

- Hemoglobin (Hb, g/dL)
- Hematocrit (Hct, %)
- Total leukocyte count (TLC, $\times 10^9$/L)
- Platelet count ($\times 10^9$/L)
- Differential leukocyte count (%)

Disease Severity Classification: Patients were classified into uncomplicated and severe malaria as per WHO guidelines (criteria including cerebral malaria, severe anemia, jaundice, renal failure, hyperparasitemia).

Statistical Analysis: Data were analyzed by SPSS version 25. Descriptive statistics were shown as mean ± SD. Group comparisons were performed by applying the chi-square test for categorical and by t-test/ANOVA for continuous variables. P-value less than 0.05 was considered as statistically significant.

Results

Patient Characteristics: A total of 200 patients were included: 120 (60%) with P. vivax, 60 (30%) with P. falciparum, and 20 (10%) with mixed infections. The mean age was 34.6 ± 12.5 years, with male predominance (62%).

Hematological Findings

- **Anemia (Hb <10 g/dL):** Present in 90 patients (45%), most frequent in P. falciparum (55%) and mixed infections (60%).
- **Thrombocytopenia (<150 $\times 10^9$/L):** Observed in 144 patients (72%). Severe thrombocytopenia (<50 $\times 10^9$/L) occurred in 24% overall, significantly higher in P. falciparum (40%).
- **Leukocyte abnormalities:** Leukopenia in 28%, neutropenia in 18%, lymphopenia in 25%. Leukocytosis was rare (5%).
- **Hematocrit:** Mean Hct was significantly lower in P. falciparum patients (28.1 ± 4.2%) compared to P. vivax (32.5 ± 3.8%).

Table 1: Demographic and Clinical Profile of Malaria Patients (n=200)

Parameter	P. vivax (n=120)	P. falciparum (n=60)	Mixed (n=20)	Total (n=200)
Mean Age (years)	33.8 ± 11.6	35.2 ± 13.1	37.4 ± 12.2	34.6 ± 12.5
Male (%)	65 (54%)	45 (75%)	14 (70%)	124 (62%)
Severe Malaria (%)	12 (10%)	20 (33%)	8 (40%)	40 (20%)

Table 2: Hematological Parameters by Species

Parameter	P. vivax	P. falciparum	Mixed	p-value
Hb (g/dL, mean ± SD)	10.8 ± 1.9	9.6 ± 2.1	9.2 ± 2.0	<0.05
Hct (%)	32.5 ± 3.8	28.1 ± 4.2	27.6 ± 4.0	<0.05
Platelets (×10⁹/L)	102 ± 46	72 ± 40	68 ± 35	<0.01
TLC (×10⁹/L)	5.6 ± 2.0	4.9 ± 1.8	4.7 ± 2.2	NS

Table 3: Frequency of Cytopenias

Abnormality	P. vivax (%)	P. falciparum (%)	Mixed (%)	Total (%)
Anemia (Hb <10 g/dL)	42 (35%)	33 (55%)	12 (60%)	90 (45%)
Thrombocytopenia (<150)	75 (62%)	50 (83%)	19 (95%)	144 (72%)
Severe Thrombocytopenia (<50)	18 (15%)	24 (40%)	6 (30%)	48 (24%)
Leukopenia (<4)	26 (22%)	20 (33%)	10 (50%)	56 (28%)

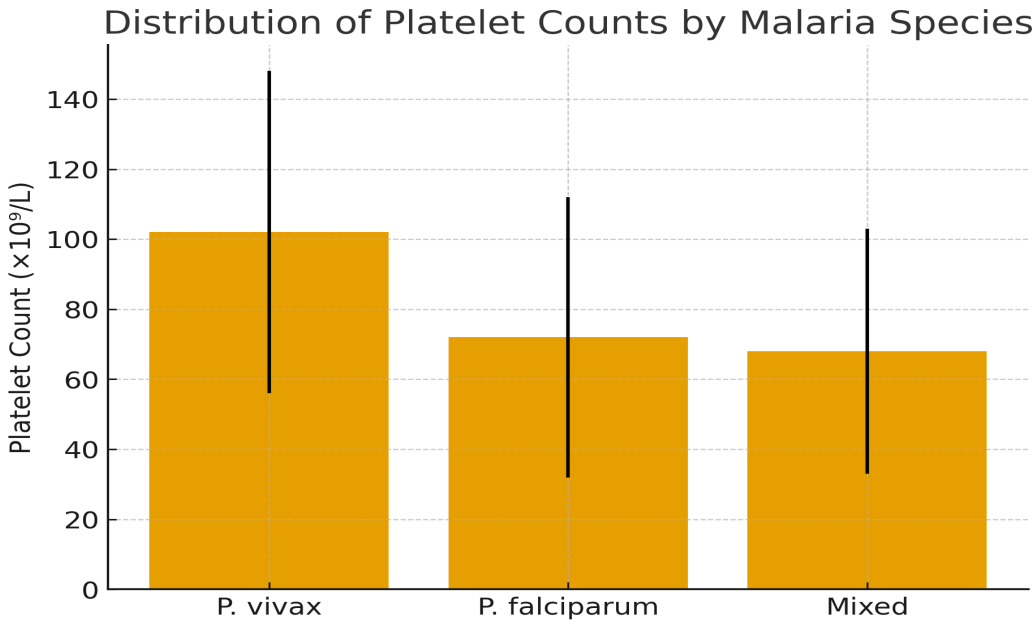

Figure 1: Distribution of Platelet Counts by Malaria Species

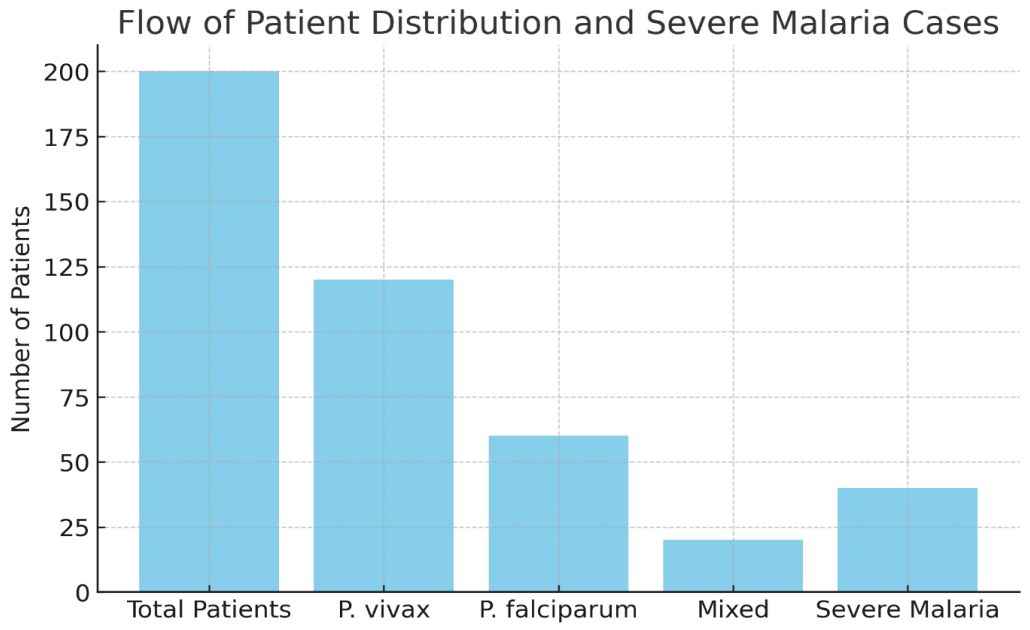

Figure 2: Flow Diagram of Patient Distribution and Hematological Abnormalities

Discussion

This study highlights the significant hematological abnormalities associated with malaria, reinforcing their diagnostic and prognostic value. Among 200 patients, thrombocytopenia and anemia were the most prevalent findings, consistent with previous reports [9,10].

Thrombocytopenia was present in 72% of patients, with severe thrombocytopenia in 24%. The prevalence was significantly higher in P. falciparum and mixed infections. Similar findings were reported by Erhart et al. [11], who demonstrated that platelet counts decline markedly in falciparum malaria due to peripheral destruction, splenic sequestration, and immune-mediated mechanisms. Thrombocytopenia, though rarely leading to bleeding, serves as a sensitive marker of malaria infection in endemic settings [12].

Anemia affected nearly half of the cohort, more common in P. falciparum and mixed infections. The mechanisms are multifactorial: intravascular hemolysis of parasitized and non-parasitized RBCs, dyserythropoiesis, and immune-mediated clearance [13]. The association between anemia severity and parasitemia suggests that monitoring hematological parameters may help predict disease severity.

Leukocyte abnormalities were less consistent. Leukopenia (28%) and lymphopenia (25%) reflect immune suppression and redistribution of leukocytes to peripheral tissues [14]. Our findings align with Kotepui et al. [6], who noted species- and density-dependent leukocyte variations.

P. falciparum and mixed infections showed significantly lower Hb, Hct, and platelet counts than P. vivax. This supports evidence that falciparum malaria exerts greater hematological impact due to higher parasitemia and sequestration phenomena [15]. Increasing reports of severe manifestations in P. vivax infections, however, challenge its classification as benign [7].

Routine hematological profiling in malaria-endemic regions provides valuable adjunctive information for diagnosis and monitoring. Severe thrombocytopenia, in particular, may alert clinicians to possible P. falciparum infection. Early recognition and intervention may reduce complications and improve outcomes.

Limitations

This was a single-center study with moderate sample size. Pediatric and pregnant populations were excluded, limiting generalizability. Molecular confirmation of species was not performed. Despite these, the study provides valuable insights into hematological profiles of malaria in our setting.

Conclusion

Malaria produces characteristic hematological alterations, with anemia and thrombocytopenia being the most prominent. P. falciparum and mixed infections exhibit more profound changes compared to P. vivax, correlating with disease severity. Hematological profiling thus serves as a simple, cost-effective adjunct for diagnosis, severity assessment, and monitoring of malaria patients in endemic regions. Incorporating hematological markers into routine malaria management may improve early recognition of complications and guide timely interventions, ultimately reducing morbidity and mortality.

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