

Original Research Article

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Study of haematological parameters in malaria

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ABSTRACT

Background: Malaria causing plasmodia are parasites of blood and hence induce haematological alterations. The haematological changes that have been reported to accompany malaria include anemia, thrombocytopenia and leucocytosis, leukopenia, mild to moderate atypical lymphocytosis, monocytosis, eosinophilia and neutrophilia.

Methods: Total hundred smear positive malaria cases were taken and various hematological parameters and biochemical parameters were studied.

Results: Out of 100 smear positive cases, *P. vivax* was positive in 55 cases while *P. falciparum* was positive in 45 cases. It was seen in 86.67% of *falciparum* Malaria patients and in 72.72% of *vivax* Malaria patients. Severe anemia was seen in 9% of patients. Normocytic normochromic blood picture was the most common type in anaemic patients (51.89%). Thrombocytopenia was seen in 71% of the patients. Mild thrombocytopenia was more common and present in 52% of patients while Severe thrombocytopenia was seen in 19% of cases. In *falciparum* malaria thrombocytopenia was present in 66.66% of the patients while it was present in 74.54% of the patients in *vivax* malaria. Total Leucocyte Count was normal in 72% of the patients.

Conclusions: Various haematological findings can help in early diagnosis of malaria which is essential for timely and appropriate treatment which can limit the morbidity and prevent further complications.

Keywords: CBC, Haematological parameters, Malaria, Thrombocytopenia

INTRODUCTION

"Malaria" received its name from Italian as it was believed to arise due to foul air common near marshy areas. More than 100 countries in the world are considered malarious, and more than 2.4 billion of the world's population is at risk. The worldwide annual incidence of malaria is estimated to be about 300-500 million cases. Malaria kills between 1.1 and 2.7 million people annually of which majority are children under five years.¹

Malaria is a major health problem in India, being one of the biggest burdens in terms of morbidity and mortality among all infectious diseases.²

Malaria causing plasmodia are parasites of blood and hence induce hematological alterations. The hematological changes that have been reported to accompany malaria include anemia, thrombocytopenia and leucocytosis, leukopenia, mild to moderate atypical lymphocytosis, monocytosis, eosinophilia and neutrophilia.³⁻⁸ Platelet abnormalities are both qualitative as well as quantitative.

Thrombocytopenia is common occurrence in acute malaria and it is observed in *vivax* and *falciparum* malaria to varying degrees.⁶⁻¹⁰ Cases of malaria associated renal and hepatic impairment have been reported from different parts of malaria endemic countries.¹¹ Hepatic involvement in *P. falciparum* malaria

is not an uncommon presentation and presence of jaundice (bilirubin >3mg/dl) is one of the indicators of severe malaria as defined by the WHO. Jaundice in *falciparum* malaria may vary from mild to severe and is associated with high incidence of complications and mortality.¹²

There are two major renal syndromes associated with Malaria. (1) A chronic and progressive glomerulopathy that mainly affects African children, classically complicating quartan malaria and (2) ARF associated with *falciparum* malaria in Southeast Asia, India, and sub-Saharan Africa.¹³ Renal impairment is commonly caused by *P. falciparum*; however, *vivax* malaria also causes renal impairment.¹⁴

Hence the present study is undertaken to evaluate the various haematological parameters as well as biochemical parameters affected in malaria and to observe the variations if any, in *P. falciparum*, *P. vivax* and mixed infections. The aim of the study is to study the changes in haematological parameters in smear positive malaria cases. To study the changes in biochemical parameters in smear positive malaria cases. To compare these changes in *P. vivax* and *P. falciparum* infection.

METHODS

Source of data

This is a prospective and retrospective study conducted in present institute during the period December 2011 to November 2013. 100 patients showing smear positivity for one or more species of malaria parasite were included in study.

The blood samples of these patients were subjected for following laboratory investigations before starting anti-malarial drugs in all these cases.

Collection of blood

CBC was carried out on Mythic 18 Automated Hematology Cell Counter and following readings were noted.

- Hemoglobin (HB%)
- HCT
- Total leukocyte count (TLC)
- Differential leukocyte
- Platelet count.

Biochemical Investigations

Liver function test (LFT)

The patient's samples were processed for Liver function tests including-Serum Bilirubin, AST, ALT with the help of Fully Automated Biochemistry Analyser Erba-640.

Kidney function test (KFT)

The patient's samples were processed for Kidney function tests including-Serum creatinine and blood urea with the help of Fully Automated Biochemistry Analyser Erba-640.

Peripheral blood smear examination

Peripheral blood smears were prepared using fresh finger prick blood. One drop of blood placed on one side of the slide 1 cm away from end and blood was spread using a spreader slide at angle of 30 degree over the length of slide then slides were left to air dry. Slides were fixed and stained with Leishman stain. Peripheral blood smear examination was done systematically under low, high and oil immersion of microscope for

- RBC morphology
- Total leukocyte count and differential count
- Platelet adequacy
- Type of malaria parasite.

RESULTS

Total hundred smear positive malaria cases were taken and various hematological parameters and biochemical parameters were studied. Out of 100 smear positive cases, *P. Vivax* was positive in 55 cases while *P. falciparum* was positive in 45 cases. Out of 100 cases, *P. vivax* was the most common observed species. It was seen in 55% of cases. Next common was *P. falciparum* accounting for 45% of cases.

Table 1: Malaria cases with different species distribution.

Type of parasites	No of patients	Percentage (%)
P. Vivax	55	55
P. Falciparum	45	45
Mixed	0	0
Total	100	100

Most of the cases (57%) were in the adults between 21-40 years age group. There were 20 % of cases below 20 yrs of age group. People of all age groups were seen. Youngest was 1 year old female child with *P. vivax* infection and oldest was 78 years old female with *P. falciparum* infection. There were 57 male patients and 43 female patients. Falciparum cases were almost equal in both sexes while Vivax infections were found slightly more in males. Fever was seen in all cases except one case. Chills and rigor was the next commonest symptom seen in 64% of the cases. Nausea and vomiting was present in 25 cases out of which majority (16 cases) were due to *falciparum* malaria. Myalgia was present in 14% of cases. Altered sensorium was seen in 3 cases of *falciparum* and 1 case of *vivax* infections.

Table 2: Clinical signs in malaria infection.

Sign	P. falciparum	P. vivax	Total%
Pallor	29	26	55%
Icterus	7	4	11%
Pedal edema	3	2	5%
Splenomegaly	19	13	32%
Hepatomegaly	11	9	20 %
Hepatosplenomegaly	9	8	17 %
CNS involvement	3	1	4 %

Pallor was the most common clinical sign and was present in 55% of cases. Splenomegaly was present in 32 % of cases. splenomegaly seen in 17% of cases with near

equal distribution in Falciparum and Vivax malaria. Icterus was present in 11% of cases. CNS involvement seen in 3 cases of *P. falciparum* and 1 case of *P. vivax*.

Investigations

Haemoglobin concentration (Hb%)

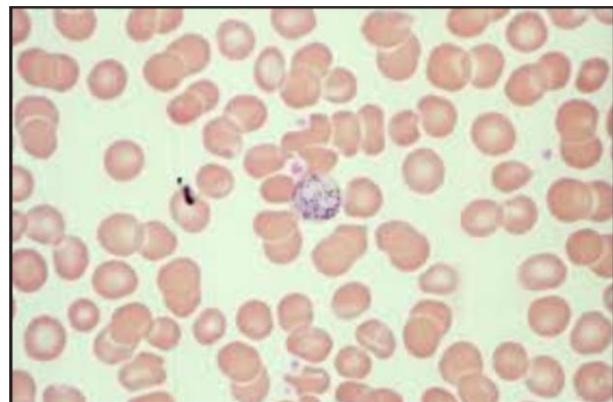
Majority of the patients had either mild (40%) or moderate degree (30%) of anemia. Hb Concentration <7 gm% was seen in 9% of the cases; more in Falciparum infection. Haematocrit values less than 20 were seen in 9% of the patients which was slightly more common in *Falciparum* infection. (11.11%). Most of the patients (68%), showed haematocrit level in the range of 20-35%.

Table 3: Platelet count.

Platelet count	P. falciparum (n=45)	P. vivax (n=55)	Total %
Thrombocytopenia (less than 1.5 lakhs/mm ³)	30 (66.66%)	41 (74.54%)	71%
Normal platelet count (more than 1.5 lakhs/mm ³)	15 (33.33%)	14 (25.46%)	29%

**Figure 1: Gametocyte of *P. falciparum*.**

Decreased platelet counts were a constant feature of both types of malaria with 71% of cases showing Platelet Count less than 1.5 lakhs/mm³. Severe Platelet Reduction (<50,000) was seen in 19 cases.

**Figure 2: Schizont of *P. vivax*.**

Total leucocyte count (TLC)

Majority of the patients had normal Total WBC count (72%). Reduced WBC count was seen in 18% of the cases and increased counts in 10%, with near equal distribution in *vivax* and *falciparum* malaria. Increased WBC count seen in 10% of cases. 5 cases of increased neutrophil count were seen, with more in *vivax* infection (4 cases).

Reduced neutrophil count was seen in 12 cases with equal distribution in *vivax* and *falciparum* malaria cases. One case of eosinophilia and 6 cases of lymphocytosis were seen in *falciparum* malaria cases. Two cases of lymphocytosis were seen in *vivax* infection. Seventy-four cases showed normal differential count.

In anemic patients, most commonly RBC's were Normocytic Normochromic (64.55%) followed by Microcytic Hypochromic (29.11%) Microcytic Hypochromic blood picture was seen nearly equal in both *falciparum* and *vivax* infection. T

Three cases of Macrocytic and two cases of dimorphic blood picture were also seen. Out of the 100 patients, 11 had jaundice. Among them, 7 had *falciparum* malaria and 4 had *vivax* malaria. The diagnosis of malarial hepatitis was made in 3 patients of *falciparum* malaria on basis of: Demonstration of Plasmodium infection, at least 3-fold

raise in transaminase (especially ALT), with or without conjugated hyperbilirubinaemia, absence of clinical and serological evidence of viral hepatitis and response to antimalarial drugs.

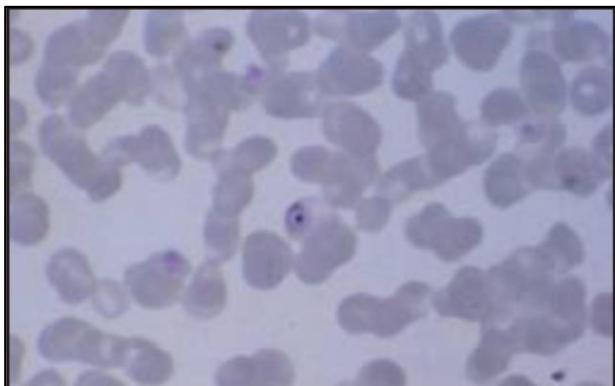


Figure 3: Ring Worm of *P. vivax*.

Renal function tests

Serum creatinine level >3.0 mg/dL. It was seen in 1 adult patient. She had Falciparum malaria.

DISCUSSION

Malaria is transmitted by the female anopheles mosquito, causes clinical illness and pathological changes in various body organs with the parasites invading and multiplying in the circulating red blood cells. Malaria causes numerous hematological alterations of which anemia and thrombocytopenia are the most important.

The most common species of malaria in the present study was *vivax* (55%) followed by *falciparum* (45%). In studies conducted by Erhart LM et al, Jadhav UM et al, *vivax* was the most common species while Bashawri LAM et al reported higher *falciparum* prevalence.^{3,16,17} In

India, *vivax* is the most common species encountered followed by *falciparum*. However, in recent years there has been an upswing in the *falciparum* cases.

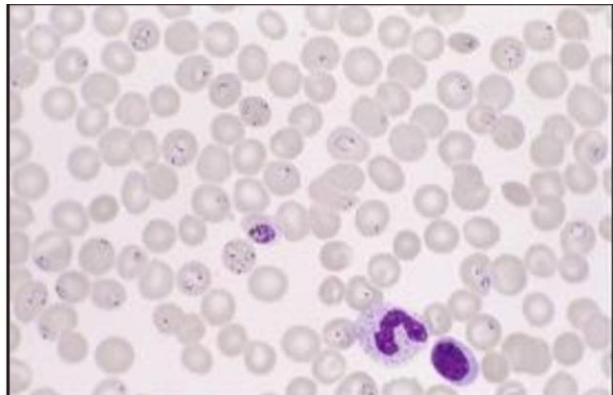


Figure 4: Ring form of *P. falciparum* (heavy parasitemia).

Malaria can affect any age group. However, most studies show more of adults as compared to children. The present study had 80 adult patients and 20 patients below age 20 yrs. The mean age of the present study is 30.4 years. Most other studies have mean age groups between 25 and 40. The adult age group is more affected due to their greater mobility and greater risk of exposure due to more outdoor activity. Present study had 57% male patients as compare to 45% female patients. Other studies with comparable results include Jadhav UM et al with 58.3% males, Erhart LM et al with 69% males and Bashawri LAM et al with 75.9% males.^{3,16,17}

In present study, Fever was the commonest presenting symptom in 99% of the patients. Chills and rigor was present in 64% of the patients. Nausea and vomiting was seen in 25% of the patients. Headache was seen in 22% of the patients while Altered Sensorium was seen in 4% of patients.

Table 4: Comparison of malaria caused by different species.

Type of infection (%)	Bashawri LAM et al ³	Erhart LM et al ¹⁶	Jadhav UM et al ¹⁷	Present study
<i>P.vivax</i>	39	59	62.17	55
<i>P. falciparum</i>	54.1	38	37.69	45
Mixed	2.33	2	0.04	0

As seen in other studies and our study, Fever is most common symptom. Also chills and rigor, nausea and vomiting, headache are still the common symptoms of malaria. Even though malaria is commonly associated with thrombocytopenia, rash and petechial hemorrhages in the skin or mucous membranes are not the common presentation features.

In present study, Pallor was seen in 55% followed by splenomegaly in 32% of cases, hepatomegaly in 20%, Icterus in 11% and CNS involvement in form of seizures and altered sensorium in 4%, and Pedal oedema in 5% of the patients. Variations in different studies may be due to some studies having concentrated only on malarial hepatitis and jaundice in malaria and others on hematological parameters only. Anaemia is a frequent

finding in malaria cases, particularly in developing nations. In the present study, anaemia (<11.5 gm %) was seen in 79% of the cases. In other studies carried out, Sharma Set al had anaemia in 86.7% of the cases, while in a study conducted by Biswas R et al, 94.4% of the cases had anaemia.^{8,21} In study conducted in Saudi Arabia, Bashawri LAM et al had 59.2 % cases showing Anaemia.³

Table 5: Comparison of patient age distribution (mean age).

Studies	Mean age in years
Bashawri LAM et al ³	25.4
Jadhav UM et al ¹⁷	37.4
Erhart LM et al ¹⁶	28
Present study	30.47

In present study, severe anaemia (<7gm%) was seen in 9% of cases, while study conducted by Bashawri LAM et al had severe anaemia in 5.5% of cases.³ There is a wide variation in anaemia due to malaria infection depending upon the geographical location of the study. In study conducted by Richard MW et al in London only 15% cases of malaria show anaemia.²²

Studies conducted in developing countries show higher levels of anaemia. In the present study, Leucocytosis was seen in 10% of the cases. Study by Bashawri LAM et al show 7.2% cases with Leucocytosis.³ Sharma SK et al and Biswas R et al show 13.3% and 12.2% cases respectively which are almost similar to the present study.^{8,21} More prominent rise (20%) was reported by Ladhan S et al who studied *falciparum* cases only, and

Echieverri M et al studying *vivax* cases had only 5% cases of leucocytosis.^{15,23}

Changes in the WBC are less definite in malaria and there is a wide variation seen among the studies. Usually Total counts in majority of the patients are within normal limits. In the present study 72% of the patients had normal counts. In the present study; increase in Leucocytes in Vivax is seen in 7.8% of the cases while in Falciparum, 10.4% cases show increased Leucocyte count.

Leucopenia was seen in 18% of the total cases in the present study. In cases of *vivax* infection, 19.6% of the cases show fall in Leucocytes while in Falciparum infection 16.6% of the cases show leucopenia. Sharma SK et al observed leucopenia in 6.6% cases in *falciparum* malaria and Ladhan S et al in 10.2% in *falciparum* malaria.^{8,15} Bashawri LAM et al had leucopenia in 13.3% of the total malaria cases. Study by Echieverri M et al had 29% cases of leucopenia in *vivax* malaria cases.^{3,23}

While all studies show some changes in the total WBC counts, there is a difference in values. Hence an alteration in the WBC count is not unprecedented either for *P. falciparum* or *P. vivax* though the quantum of changes may vary. Present study showed increased neutrophils in 5% of the cases and neutropenia in 12% of the cases.

Similar values are seen in study by Bashawri LAM et al showing 8.3% and 11.6% neutrophilia and neutropenia respectively. Lymphocytosis was seen in the present study in 8% of the cases. Similarly, Biswas et al reported 8.5% cases with lymphocytosis.^{3,21}

Table 6: Comparison of clinical signs.

Signs	Pallor	Icterus	Splenomegaly	Hepatomegaly	CNS Involvement
Farogh A et al. ¹⁸	92%	14%	72%	48%	40%
Muddaiah A et al. ¹⁹	11.5%	15.7%	15.7%	4.2%	4.21%
Piplani S et al. ²⁰	13.1%	6.5%	65.7%	53.9%	-
Present study	55%	11%	32%	20%	4%

In the present study, the percentage of patients showing thrombocytopenia (<1.5 lacs) were 66.66% in case of *falciparum* malaria and 74.54% in case of *vivax* malaria. The percentage of cases showing thrombocytopenia in *falciparum* infections and *vivax* infections varies in different studies. Studies conducted by Bashawri LAM et al and Jhadav UM et al had thrombocytopenia more in Vivax as in the present study while in study conducted by Erhart LM et al, thrombocytopenia is more in cases of *falciparum* malaria.^{3,16,17} Thrombocytopenia is a common finding in cases of malaria both *vivax* and *falciparum* as shown by most of the studies conducted. In the present study thrombocytopenia was seen in 71% of all malaria

cases. Study conducted by Richards MW et al had thrombocytopenia in 67% of the case.²²

Jaundice was seen in 11% of study group. This Incidence of jaundice is similar to study conducted by Kochar D et al who had 12% of cases with jaundice.²⁴ One had unconjugated hyperbilirubinemia. Majority had conjugated hyperbilirubinemia (10 out of 11).⁷ had *falciparum* malaria and 4 had *vivax* malaria. Three cases fulfilled criteria of Malarial hepatitis. This was almost similar to study of Anand AC et al, who had incidence of malarial hepatitis in 2.4% of cases.²⁵ Renal failure in the form of acute renal failure was noted in one patient with

falciparum malaria (2.77%). Study by Kochar D et al had the incidence of renal failure to be 2%. No patients with *vivax* malaria had renal failure.²⁴

CONCLUSION

Malaria is one of the most common infections in Indian Subcontinent. Malaria affects mostly adults with male predominance. Fever, Pallor and Splenomegaly are common clinical features in malaria. Malarial infection causes various haematological and biochemical changes. Anaemia and thrombocytopenia of varying severity are most frequently observed haematological findings however bleeding manifestations are uncommon. In a patient with febrile illness, observation of thrombocytopenia warrants careful search for malaria parasite. *P. falciparum* is associated with serious complications like Severe anemia, Malarial hepatitis and Renal failure hence *P. falciparum* infection on suspicion of complication should be further evaluated. Various haematological findings can help in early diagnosis of malaria which is essential for timely and appropriate treatment which can limit the morbidity and prevent further complications.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

- Taylor TE, Strickland GT. Malaria. In: Strickland's infectious Disease, 4th ed. London: Wiley. 2006:614-42.
- Park K. Malaria. In Preventive and social medicine. 17th ed. Publishers Banarsidas Bhanot Publishers. Jabalpur. 2002:192-201.
- Bashawri LAM, Mandil AA, Bahnassy AA, Ahmed MA. Malaria: Haematological Aspects. Annals of Saudi Medicine. 2002;22(5-6):372-77.
- Kelkar DS, Patnaik MM, Joshi SR. Malarial Hematopathy. J Assoc Physicians India. 2004;52:611-4.
- Niazi GA. Haematological aspect of malaria in a population based hospital, Saudi Arabia. J Egypt Soc Parasitol. 1995;25(3):787-93.
- Sen R, Tewari AD, Sehgal PK, Singh U, Sikka R, Sen J. Clinico-haematological profile in acute and chronic plasmodium falciparum malaria in children. J Commun Dis. 1994;26(1):31-8.
- Rojanasthien S, Surakamolleart V, Boonpucknavig S, Isarangkura P. Hematological and coagulation studies in malaria. J Med Assoc Thai. 1992;75 Suppl 1:190-4.
- Sharma SK, Das RK, Das BK, Das PK. Haematological and coagulation profile in acute falciparum malaria. J Assoc Physicians India. 1992;40(9):581-3.
- Srichaikul T, Pulket C, Sirisatepisarn T, Prayoonwiwat W. Platelet dysfunction in malaria. Southeast Asian J Trop Med Public Health. 1988; 19(2):225-33.
- Kakar A, Bhoi S, Prakash V, Kakar S. Profound thrombocytopenia in plasmodium vivax malaria. Diagn Microbiol Infect Dis. 1999;35(3):243-4.
- Ogbadoyi EO, Tsado RD. Renal and Hepatic Dysfunction in Malaria Patients in Minna, North Central Nigeria. Online J Health Allied Sci. 2009;8(3).
- Abro AH, Ustadi AM, Abro HA, Abdou AS, Younis NJ, Akaila SI. Jaundice with hepatic dysfunction in *P. falciparum* malaria. J Coll Physicians Surg Pak. 2009;19(6):363-6.
- Barsoum RS. Malarial acute renal failure. J Am Soc Nephrol. 2000;11(11):2147-54.
- Rajapurkar MM. Renal involvement in malaria. J Postgrad Med. 1994;40:132-4.
- Ladhani S, Lowe B, Cole AO, Kowundo K, Newton RJC. Changes in white blood cells and platelets in children with falciparum malaria: relationship to disease outcome. Brit J Haematol 2002;119(3):839-47.
- Erhart LM, Yingyuen K, Chuanak N, Buathong N, Laoboonchai A, Miller RS et al. Haematologic and Clinical Indices of Malaria in a Semi-Immune Population of Western Thailand. Am J Trop Med Hyg. 2004;70(1):8-14.
- Jadhav UM, Patkar VS, Kadam NN. Thrombocytopenia in Malaria - Correlation with Type and Severity of Malaria. J Assoc Physicians India. 2004;52(2):615-8.
- Farogh A, Qayyum A, Haleem A, Ghaffar A. Haematological abnormality in malaria. Biomedica. 2009;25(10):52-5.
- Muddaiah M, Prakash Ps. A study of clinical profile of malaria in a tertiary referral centre in South Canara. J Vector Borne Dis. 2006;43(1):29-33.
- Piplani S. Clinical study of Falciparum malaria in Northeast. JAPI. 2000;48(1):110.
- Biswas R, Sengupta G, Mundie M. A Controlled Study on Haemograms of Malaria Patients in Calcutta. Indian J Malariol. 1999;36(1-2):42-8.
- Richards MW, Behrens RH, Doherty JF. Hematologic changes in Acute, Imported Plasmodium falciparum Malaria. Am J Trop Med Hyg. 1998;59(6):859.
- Echieverri M, Tobon A, Alvarez G, Carmona J, Blair S. Clinical and Laboratory Findings of Plasmodium vivax Malaria in Colombia. Rev Inst Med Trop. 2003;45(1):29-34.
- Kochar D, Kumawat BL, Karan S. Severe and complicated malaria in Bikaner, western India. Southeast Asian J Trop Public Health. 1997;28(2):259-67.
- Anand AC, Ramji C, Narula AS, Singh W. Malarial hepatitis: a heterogeneous syndrome? Natl Med J India. 1992;5(2):59-62.

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