ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: www.ijmacr.com

Volume – 6, Issue – 1, Janaury - 2023, Page No. : 69 - 80

Haematological Profile of Malaria Patients

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How to citation this article: Dr. Methe M. B., Dr. Shivkumar Inamdar, "Haematological Profile of Malaria Patients", IJMACR- January - 2023, Volume – 6, Issue - 1, P. No. 69 – 80.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Amongst the infectious diseases malaria is an ancient disease known to human being. It is commonly seen in tropical and subtropical countries in Asia and Africa. Malaria is a protozoal disease caused by infection with parasite of genus plasmodium and transmitted to man by infected female anopheles mosquitos.

Objectives:

1. To study different haematological changes in malaria patients
2. To correlate hematological changes with various strains of malarial parasite.
3. To categories malaria patients according to species causing infection.

Methods: Complete blood count of 780 malaria positive cases was studied from the period of 1st Jan 2014 to 30 th June 2015 .Complete blood count was done on automated blood cell analyser and blood samples were tested on malaria antigen and antibody kits. Examination of both thick & thin blood smears was done by using Leishmans & Fields stain. All malaria positive (on blood smear) cases were included in study. Blood samples were collected from clinically suspected cases of malaria in the EDTA bulbs.

Results: Out of 780 cases studied most cases are of plasmodium Vivax (72%) followed by P. Falciparum (20%) followed by Mixed (8%) with majority of cases (87%) found in adult age group. Anaemia & thrombocytopenia are the most common findings.Out of 68% of patients with anaemia 72% cases were p. falciparum. Thrombocytopenia is found in 65% of cases & is more common in P. Falciparum than P. vivax & mixed. Majority of cases were having mild to moderate thrombocytopenia .Thrombocytopenia & severe Thrombocytopenia was more common in P. Falciparum. Degree of parasitemia found was severe in <10% of cases out of which P. Falciparum cases were more than Vivax & Mixed. Majority of cases were having mild to moderate degree of thrombocytopenia.

Conclusion: Malaria causes widespread changes in hematological parameters. Anemia and

thrombocytopenia are the most common findings. These changes are more common and severe in falciparum infection than vivax. Blood smear examination is gold standard for diagnosis of malaria and rapid diagnostic tests can increase the diagnostic outcomes when used along with smear examination. So in this era of improved diagnostic techniques and treatment modalities early diagnosis of malaria by considering these hematological and histogram changes can lower morbidity and mortality associated with the disease.

Keywords: Malaria, Anaemia, Thrombocytopenia, Parasitemia.

Introduction

Amongst the infectious diseases malaria is an ancient disease known to human being. It is commonly seen in tropical and subtropical countries in Asia and Africa. Malaria is a protozoal disease caused by infection with parasite of genus plasmodium and transmitted to man by infected female anopheles mosquitos. Plasmodium genus includes four species,pathogenic to man, P.vivax, P.falciparum, P.malarie and P.ovale.[1]

Early diagnosis of malaria is the key feature for its prompt treatment and prevention of complications which may include hypoglycaemia, acidosis, renal failure, pulmonary edema or coma.Clinical diagnosis of malaria is challenging because of non-specific signs and symptoms which overlap with other febrile illnesses. In spite of advances in diagnostic techniques and treatment malaria continues to cause significant morbidity and mortality[1].

Approximately 300 million people worldwide are infected with malaria and each year between 1-1.5 million die due to malaria.[2]Most deaths occur because of P.falciparum. In India there are approximately 1.8 million positive cases reported annually.P.vivax is the commonest (60-70%), followed by P.falciparum (30-45%). P.malarie species is rarely found and P.ovale is not reported in India.[2]

Hematological changes are some of the most common complications in malaria and they play a major role in malaria pathology[3]. These changes involve the major cell lines such as red blood cells, leucocytes and thrombocytes. The haematological changes that have been reported to accompany malaria include anaemia, thrombocytopenia & Leucocytosis, leucopenia, lymphocytosis and Leucopenia, leucocytosis, neutropenia, neutrophilia, monocytosis and eosinophilia also have been reported.[3]

Most common complication being thrombocytopenia, Persons with <1.5 lakhs of platelets are more likely to have malaria than persons with platelet count >1.5lakhs.[4]

Malarial parasite affects multiple organs like liver, spleen, gallbladder, pancreas, brain, GI & Kidney which involves parasitic sequestration& cytokine mediated injury to RBCs & Platelets.[5]

Prediction of these changes in haematological parameters enables the clinician to establish an effective and early therapeutic intervention so as to prevent occurrence of major complications.[6]

The present study is aimed to observe the haematological changes in malaria cases and to observe variations if any in vivax, falciparum and mixed (vivax and falciparum) malaria cases.

Materials and Method

A) Blood smear examination

Examination of blood smears for parasite detection is gold standard method in spite of many advances in the diagnostic tools of malaria. This examination should be a routine procedure in medical practice, not only in all malarious areas, but also in non malarious countries,

whatever may be the symptoms of primary diagnosis, if the patient has been travelling abroad within a year.

The aims of blood examination are to find out if the patient is infected, the level of infection and the species of the parasite.

Parasites are most numerous in peripheral blood late in the febrile paroxysm, few hours after the peak of fever. It is advisable to make smear from finger prick. But if not possible smears can be made from anticoagulated blood samples. Potassium –EDTA is preferred anticoagulant.

Two types of blood smears are prepared for examination – Thick smear &Thin smear.

Thick smear

After cleaning with either spirit and drying, the fingertip is pricked and gently squeezed till good drop of blood exudes. The drop of blood is touched with clean dry slide, near one end. The blood on the slide is spread with the corner of another slide to produce square or circular patch of moderate thickness. This is the thick film. When correctly prepared the thick film will just allow printed letters to be read through it. Then smear is kept for air drying. After air drying smear is dehemoglobinised and then stained with Giemsa or Leishman stain.

Thin smear

For making thin smear small drop of blood is taken on slide and spread evenly and thinly with edge of spreader slide. A properly made thin smear will consist of an unbroken smear of single layer of red cells , ending in a tongue which stops a little short of the edge of the slide. After airdrying the smear it is fixed in methanol for 30 seconds and stained by Giemsa or Field's stain. Leishman stain can also be used. The rapid method commonly employed in India is the JSB stain named after Jaswant Singh and Bhattarcharji. As single layer of red blood cells with preserved morphology are seen species identification can be done.

Various forms of the parasite seen on the smear as per the species are –

Parasite species	Forms seen on smear
P.Vivax	Tropozoites, SCHIZONT & Gametocytes
P. Falciparum	Ring (Early tropozoites) & Gametocytes
P. Malariae	Tropozoites ,Schizont & gametocytes
P. Ovale	Tropozoites,Schizont & gametocyte

Results

Out of 780 cases of malaria majority of the cases were due to P. vivax infection (71.92%). P. falciparum was second most common species contributing 20% cases and mixed infection with P. falciparum and P. vivax seen in 8.08% cases.

Table 1: Number of cases of malaria

Species	P.Vivax	P.Malariae	Mixed	Total
Number	561	156	63	780
%	71.92	20	8.08	100

Table 2:Comparison of kit results

In the present study blood smear positive 780 cases were included. Out of these 718 cases were positive for malaria antigen by rapid diagnostic kits which accounts for 92.05% of total cases while 603 cases were positive for malarial antibodies by rapid diagnostic kits which accounts for 77.30% of total cases.

Number of positive cases	% of positive cases
718	92

Table 3: Age wise distribution of cases

Majority of the cases were of adult age group (mean age 32.12) in all three species. 87.95 % cases were of more than 12 year age.

Age	P. Vivax	P. Falciparum	Mixed	Total	%
0-12	72	20	02	94	12.05
>12	489	136	61	686	87.95
Total	561	156	63	780	100

Table 3: Sex wise distribution

	P.Vivax	P.Falciparum	Mixed	Total	%
Male	412	112	55	569	74.23
Female	149	42	08	201	15.77
Total	561	156	63	780	100

In overall cases of malaria majority (76.41%) were having normal leucocyte count.Leucopenia was more frequent (17.95%) than leucocytosis (5.64%).Both leucopenia and leucocytosis were more prominently seen in falciparum cases(21.15% & 7.70% respectively) as compared to vivax (17.29% & 5.17%) and mixed(15.87% & 4.76%) cases.

Table 4: Comparison of TLC

	P.Vivax	P.Falciparum	Mixed	Total	%
Leucopenia	97	33	10	41	17.95
Normal	435	111	50	596	76.41
Leucocytosis	29	12	03	55	5.64
Total	561	156	63	780	100

Overall 12.56 % of the cases were having lymphocytosis. Amongst the species.falciparum (15.38%) cases were having more pronounced lymphocytosis followed by mixed (12.70%) and vivax (11.76%).

Table 5; Comparison of lymphocyte count

	P. Vivax	P. falciparum	Mixed	Total	%
Normal	495	132	55	682	67.44
Lymphocytosis	66	24	08	98	12.56
Total	561	156	63	780	100

In overall cases of malaria majority (77.44%) were having normal neutrophil count.Neutropenia was more common (15.13%) than neutrophilia (7.43%).On comparing data of species falciparum (17.95%) cases were showing moreprominent neutropenia than vivax (14.62%) and mixed (12.70%) cases.Neutrophilia was more common in mixed (9.52%) than vivax (7.84%) and least in falciparum (5.13%)

Table 6: Comparison of neutrophil count

	P.Vivax	P.Falciparum	Mixed	Total	%
Neutropenia	82	28	08	118	15.13
Normal	435	120	49	604	77.44
Neutrophilia	44	08	06	58	7.43
Total	561	156	63	780	100

Majority of the cases (97.44%) were having normal eosinophil count. Eosinophilia was seen in few cases of falciparum (3.21%), mixed (3.17%) and vivax (2.32%).

Table 6: Comparison of Eosinophil count

	P.Vivax	P.Falciparum	Mixed	Total	%
Normal	548	151	61	760	97.44
Eosinophilia	13	05	02	20	2.56
Total	561	156	63	780	100

Overall 8.46 % cases were having monocytosis. Comparing species falciparum cases (11.54%) were showing more frequent monocytosis and vivax cases (7.49%)showing least occurrence.

Table 7: Comparison of Monocyte Count

	P. Vivax	P. Falciparum	Mixed	Total	%
Normal	519	138	57	714	91.54
Monocytosis	42	18	06	66	8.46
Total	561	156	63	780	%

As shown in the table majority of the patients (68.25%) were having anemia. It was most frequently seen in falciparum cases (72.44%) than vivax (68.09%) and mixed infection (68.25%) cases.

Table 8:Comparison of Hb

Hb	P.Vivax	P.Falciparum	Mixed	Total	%
Normal	382	113	43	538	68.97
Anaemia	189	43	20	242	31.03
Total	561	156	53	780	100%

64.49 % of all cases were showing reduction in red blood cell count. Falciparum cases showing more reduction (67.31%) than mixed (61.90%) and vivax cases (63.99%).

Table 9: Comparison of RBC count

	P.Vivax	P.Falciparum	Mixed	Total	%
Reduced	559	105	39	503	64.49
Normal	202	51	24	277	35.51
Total	561	156	53	780	100

In overall 57.82 % cases were showing reduced haematocrit. Mixed cases (73.01%) were more followed by falciparum (66.67%) and vivax (53.65%)

Table 10:Comparison of Packed cell volume

	P.Vivax	P.Falciparum	Mixed	Total	%
Reduced	301	104	46	451	57.82
Normal	260	52	07	329	42.18
Total	561	156	63	780	100

Most of the cases (74.11%) were having normal MCV.Reduction in MCV was seen more commonly (21.92%) than increase.24.36% of falciparum cases were showing reduced MCV followed by vivax (22.11%)and mixed (14.28%)

Table 11: Comparison of Mean cell volume

	P.Vivax	P.Falciparum	Mixed	Total	%
Reduced	124	38	09	171	21.92
Normal	421	106	51	578	74.11
Increased	16	12	03	31	3.97
Total	561	156	63	780	100

Most of the all cases were having normal MCH (73.58%).Reduction in MCH was more common in falciparum cases (31.41%).

Table 12:Comparison of Mean Cell Heamoglobin

	P.Vivax	P.Falciparum	Mixed	Total	%
Reduced	140	49	17	206	26.41
Normal	421	107	46	574	73.58
Total	561	156	63	780	100

Most of the all cases were having normal MCHC (76.15%).Reduction in MCHC was more common in falciparum cases (31.41%).

Table 13:Comparison of Mean cell haemoglobin concentration

	P.Vivax	P.Falciparum	Mixed	Total	%
Reduced	128	44	14	186	23.85
Normal	433	112	49	594	76.15
Total	561	156	63	780	100

Majority of the cases (62.82%) were having Red cell distribution width (RDW) value less than 15.RDW value more than 15% was more commonly seen in falciparum cases (41.67%)than mixed (36.50%) and vivax (36.09%)

Table 14:Comparison of red cell distribution width

	P.Vivax	P.Falciparum	Mixed	Total	%
<15	359	91	40	490	62.82
>15	202	65	23	290	17.18
Total	561	156	63	780	100

Thrombocytopenia (platelet count less than 150000) was a common finding seen in 65.10 % of all cases. Most of the cases were having mild to moderate thrombocytopenia (50000-150000).

Falciparum cases were having thrombocytopenia more commonly with more incidence of severe thrombocytopenia (platelet count less than 50000) accounting for 10.90 % cases.

Table15:Comparison of platelet count

	P. Vivax	P. Falciparum	Mixed	Total	%
<50,000	39	17	04	60	7.69
50,000 to 1 lakhs	161	61	18	240	30.77

1 to 1.5 lakhs	153	44	17	214	27.44
>1.5 lakhs	208	34	24	266	34.10
Total	561	156	63	780	100

Most of the cases were having scanty to moderate parasitemia.Severe parasitemia was seen in 14.11% cases of falciparum, 9.52 % cases of mixed and 8.56% vivax cases

Table 16: Comparison of parasitemia

	P.Vivax	P.Falciparum	Mixed	Total	%
Scanty	338	78	40	456	58.46
Moderate	175	56	17	248	31.89
Heavy	48	22	06	76	9.75
Total	561	156	63	780	100

Scanty Parasitemia – 1-10 parasites per 100 thick blood fields.

Moderate Parasitemia – 11-100 parasites per 100 thick blood fields.

Heavy Parasitemia – more than 100 parasites per 100 thick blood fields.

Majority of cases were having normal MPV.

Increase in MCV was more common abnormality seen in 27.43% of cases.

30.12 % of falciparum cases were showing increased MPV.

Table 17: Comparison of MPV

MPV	P.Vivax	P.Falciparum	Mixed	Total (%)
Reduced	27	4	3	34(4.36)
Normal	283	105	44	532(68.2)
Increased	151	47	16	214(27.47)
Total	561	156	63	780

Platelet distribution width (PDW) was normal in 77.69% of all cases. Increased PDW was seen more commonly in falciparum cases (28.21%) as compared to mixed (25.40%) and vivax (20.32%)

Table 18:Comparison of PDW

PDW	P.vivax	P.Falciparum	Mixed	Total	%
Increased	114	44	16	174	22.12
Normal	447	112	27	606	77.69
Total	561	156	63	780	

Majority of the all cases (81.67%) were having platelet to large cell ratio (PLCR) less than 40.Increased PLCR was seen more commonly in falciparum cases (26.92%) as compared to mixed (17.47%) and vivax (16.04%)

Table 19: Comparison of Platelet to large cell ratio

P-LCR	P.vivax	P.Falciparum	Mixed	Total	%
<40	471	114	52	637	81.67
>40	90	42	11	143	18.33
Total	561	156	63	780	

Most of the cases (61.03%) showed normal PCT.Reduction in PCT was most common abnormality seen in 36.54% of all cases.Falciparum cases showed reduction in PCT in 42.95% cases as compared to vivax(34.94%) and mixed (34.92%).

Table 20: Comparison of Plateletcrit

PCT	P.Vivax	P.Falciparum	Mixed	Total	%
Reduced	196	67	22	285	36.54
Normal	553	85	38	476	61.03
Increased	12	04	03	19	2.43
Total	561	156	63	780	

Discussion

Malaria causes numerous haematological alterations of which anemia and thrombocytopenia are most frequent . There are many studies which indicate that precise haematological changes may vary with category of malaria with background of hemoglobinopathy, nutritional status, demographical factors and malaria immunity [6].

Most common species of malaria in the present study was P.vivax (71.92%), followed by P.falciparum (20%)

and mixed (8.08%). In studies conducted by Aarthi Rajkumar et al[11],Jadhav et al [12] and Erhart et al [13] P.vivax was the most common species while in studies by Shamim et al[19] and Singh Neeshu et al[10] P.falciparum was most common.

Comparison of Antigen and antibody detection kit results:

In the present study 780 smear positive cases were included. All the cases were tested for the presence of malarial antigens and antibodies. Out of 780 cases 718 (92.05%) were positive for malarial antigen while 603 were positive for malarial antibody.

While comparing results of antigen and antibody detection with parasitemia, as parasitemia increases rate of positive cases was also increased in case of antigen detection kits. So antigen detection method was more reliable with the greater parasitemia than at lower level of parasitemia. While in case of antibody detection kits show maximum rate of positive cases in those who were having scanty parasitemia.

Comparison of age of the cases

In the present study mean age of the cases involved by malaria was 32.12 years which is similar to study done by Aarthi Rajkumar et al [11] which showed mean age of 31.25 years. Other studies done by Jadhav et al [12], Bashwari et al [8] and Erhart et al [13] also showed most common affected age group is adults. Malaria can affect persons of any age group but majority of cases are in adult age group. Greater risk of exposure due to more outdoor activity may be the reason for this finding.

Comparison of sex wise distribution of cases (in %)

In present there was 74.23% males and 25.77% females , comparable results with Bashwari et al [8] which showed 75.9% males and 24.1% females.More of male cases may be due to more exposure because of more outdoor activity of males compared to females.

Comparison of total leucocyte count in malaria

In present study 76.41 % cases were having total leucocyte count within normal range Leucocytopenia was seen in 17.95% of cases which was common abnormal finding than leukocytosis which was seen in 5.64% cases. Study by Bashwari et al 8 shows 13.3% cases of leucocytopenia and 7.2% cases of leukocytosis which are similar to present study.Leucocytopenia is common finding in malaria although leukocytosis is also seen.Leucocytopenia is thought to be due to the localization of leucocytes away from the peripheral circulation splenic sequestration and other marginal pools rather than actual depletion or stasis

Comparing changes in leucocyte count in each species

Leucopenia was more in P.Falciparum accounting for 21.15% cases of P.falciparum followed by 17.29% cases in P.vivax and 15.87% cases of mixed infection. In the study done b Singh Neeshuet al[10] leucopenia was seen in 31% cases of P.falciparum and 21% cases of P.vivax which was similar to our study. In present study leucopenia in mixed cases was seen in 13.87% cases which was less than P.vivax and P. falciparum while other studies show variable incidence of leucopenia as compared to individual P.vivax and P. falciparum cases.

Luecocytosis was again common finding in P.falciparum which was seen in 7.70 % cases so followed by mixed cases (5.64%) and then P.vivax in which 5.17% cases showed leukocytosis. In a study done by Ali Hasan et al[17] who compared P.falciparum with P. vivax cases; p. falciparum showed more number of leukocytosis (4%) than P.vivax (2%), comparable with present study.

In a study done by Shamim et al[19] mixed cases showed 12.5% cases of leukocytosis contributing maximum

number. So finding of leukocytosis in mixed cases have variable incidence.

Comparison of differential leucocyte count

Present study shows neutroplilia in 7.43% of total cases and neutropenia in 15.13% cases. Similar results were seen in study done by Bashwari et al 8 which showed neutropenia in 8.3%cases. Study done by Biswas et al 14showed neutropenia in 14.4% cases and neutrophilia in only 0.6% cases. Majority of cases in our study have normal neutrophil count (77.49%).Neutrophilia may be due to initial stages of disease as a physiological response in fever and in some cases superadded bacterial infection is considered as a cause.

Comparison of neutropenia

Present study shows neutrophilia of 9.52 in mixed cases which was highest followed by P.vivax (7.84%) and lowest in P.falciparum (5.13%). Study by Shamim et al[19] also showed maximum incidence of neutrophilia in mixed cases i.e. 12.5% followed by P.vivax 11.11% cases an least in P. falciparum 10.25% cases. However in the study done by Ali Hasan et al [17] who compared changes between P.vivax and P.falciparum showed relatively less number of cases showing neutrophilia i.e.3% with no difference between P.vivax and P.falciparum.

In our study neutropenia was common abnormality than neutrophilia with maximum incidence in P.falciparum 17.95%followed by P.vivax and mixed 12.70%.Similar trend was seen in study carried out by Shamim et al[19]. However incidence of neutropenia was quite higher In P.falciparum (17.95%) and 14.62% in P.vivax. Study by Ali Hasan et al [18] also showed slight more incidence of neutropenia i.e. 4% in P.falciparum than P.vivax i.e. 3%.

Comparison of Lymphocytosis

Overall 12.56% cases of malaria showed lymphocytosis in present study and similar result of lymphocytosis was noted in study done by Bashwari et al [8] (13.6%). Present study shows maximum incidence of lymphocytosis in 15.38% of P.falciparum followed by mixed cases 12.70% and P.vivax 11.71%.

Study by Shamim et al[19] showed similar incidence in case of mixed infection i.e. 12.50%. But slightly lower incidence in P.falciparum and P.vivax. However comparing P.falciparum and P.vivax incidence of lymphcytosis was higher in P.falciparum.

Comparison of monocytosis

In present study overall 8.46% malaria cases showed monocytosis while 9.54 cases had normal monocyte count. Bashwari et al 8 showed about 12.4% cases of monocytosis. Comparing each species; present study showed 11.54% P.falciparm cases showing maximum incidence of moncytosis followed by mixed infection and p. vivax .study done by Shamim et al[19] showed maximum incidence of mixed cases i.e. 25% followed by P.vivax and P.falciparum.

It was observed by NKD Hakim et al[20] in their study that monocytosis in patients specially those on antimalarial therapy , may be indicative of an antimalarial effect by monocytes, thus monocytosis may enhance predisposition to a favourable outcome Monocytosis also indicates increased activity of reticuloendothelial system.

Comparison of RBC changes

Anaemia in malaria

In the present study anemia was seen in 68.97% of all cases. Bashwari et al8showed 59.2% cases with anemia showing similar results. in other studies carried out by Sharma et al7 86.7% cases had anemia, Malhotra et al 15showed 81.2% cases with anemia. Comparing species

specific data in the present study 89.7% of P.falciparum cases showed anemia, followed by 85.18% cases of P.vivax and 75% of mixed cases. Similar results were seen in studies carried by Shamim et al19, Singh Nesshu et al 10 which showed more frequent anemia in P.falciparum cases than P.vivax and mixed infection cases with variable number of cases. Ali Hasan et al 17 compared P.falciparum and P.vivax cases and observed 67% of P.falciparum and 63% of P.vivax cases had anemia. Pathogenesis of anemia in malaria is extremely complex, multifactorial and incompletely understood. It is thought to be resulted from combination of hemolysis parasitized red blood cells, accelerated removal of both parasitized and innocently unparasitized red blood cells, depressed well as ineffective erythropoiesis, with dyserythropoietic changes and anemia of chronic disease.2,3TNF alpha has also been implicated and may cause ineffective erythropoiesis. 3 Other factors contributing anemia in malaria include decreased red blood cell deformability, splenic phagocytosis and/or pooling of red blood cells.3 Hematocrit was reduced in 57.82% cases in the present study. Bashwari et al8observed 71.5% of cases with reduction in hematocrit.In the present study hematocrit was reduced in 73.01% cases of mixed infection, 66.67% cases of P.falciparum and 53.65% of cases of P.vivax. Reduced hematocrit correlated with low hemoglobin and red blood cell count in P.falciparum. Other red blood cell indices were predominantly normal in the present study. MCV was normal in 74.11% of cases, MCH was normal in 73.58% and MCHC was normal in 76.15% of cases. Reduced MCV seen in 21.92% of all cases that can be attributed to general nutritional status in population. In the present study 62.82% cases were showing red cell distribution width less than 15. Overall 37.18% cases showed increased red cell distribution width. P.falciparum again showed maximum frequency of increased RDW which was seen in 41.67% cases of P.falciparum, followed by 36.50% cases of mixed infection and 36.09% cases of P.vivax.

Comparison of Platelet count

Sn.	Study	Thrombocytopenia Cases (%)
1.	Sharma et al	90
2.	Malhotra et al	41
3.	Aarthi Rajkumar et al	44
4.	Bashwari et al	55.66
5.	Shamim et al	71.6
6.	Robinson et al	71
7.	Present study	65.90

Comparison of platelet count in malaria patients

Sn.	Study	Falciparum	Mixed	Vivax
1.	Shamim et al	79.48	75	59.29
2.	Singh Nesheu et al	83.7	77.2	77.2
3.	Jadhav et al	59	--	66.5
4.	Bashwari et al	59.9	--	74.7
5.	Hortsmann et al	85	--	72
6.	Erharts et al	67.4	--	58.3
7.	Present study	78.21	61.90	62.92

The severe degree and higher incidence of thrombocytopenia observed predominantly in complicated P.falciparum infection.[13,14,15,]In present study severe thrombocytopenia (platelet count less than 50000/cmm) was seen more commonly in P.falciparum (10.90%) than P.vivax(6.95%) and mixed infection (6.35%). Although variable degree of reduction in in circulating platelets is seen in different types of malaria[13]severe thrombocytopenia is rare in P.vivax malaria.[14] The cause of thrombocytopenia is poorly understood but the immune mediated lysis, sequestration

in the spleen and a dyspoietic process in the marrow with diminished platelet production have all been postulated. Abnormality in platelet function and structure have been described as a consequence of malaria and in rare instances platelet can be invaded by malaria parasite themselves. Two types of changes in platelet dysfunction are seen in malaria. Initially there is platelet hyperactivity followed by platelet hypoactivity. Platelet hyperactivity results from various aggregating agents like immune complexes, surface contact of platelet membrane to red cells and damage to endothelial cells. The injured platelets undergo lysis intravascularly. The release of platelet contents can activate coagulation cascade and contribute to DIC. Transient platelet hypoactivity is seen following this phase and returns to normal in 1 to 2 weeks. Immune complexes generated by malaria antigen tend to sequestration of injured platelets by macrophages in spleen.[15] It has been postulated that hypersensitive platelets will enhance hemostatic response and may be this is why bleeding episodes are rare in acute malarial infection despite of significant thrombocytopenia.[16]

Comparison of mean platelet volume

	Study	Increase in MPV
1.	Bashwari et al	25
2.	Present study	27.43

Plateletcrit (PCT)

In the present study 61.03% of cases had normal PCT. Reduced PCT was seen in 36.54 % in all cases. P.falciparum cases showed 42.955 of cases with reduced PCT with 34.94% of P.vivax and 34.92% of mixed infection cases.

Platelet distribution width (PDW)

In the present study PDW was normal in 77.69% of all cases with 22.31% cases showing increased PDW. Maximum incidence of increased PDW was seen in P.falciparum in 28.21% cases followed by 22.31% of mixed and 20.32% of P.vivax cases. Studies done by Gauri et al[18] also showed increased in PDW in malaria cases.

Platelet to large cell ratio (P-LCR)

In present study 81.67 % of cases showed normal P-LCR. 18.33% cases showed increased P-LCR. P.falciparum showed increased P-LCR in 26.92% of cases followed by 17.47% in mixed and 16.04% in vivax cases.

Conclusion

The present study titled “Hematological changes in Malaria” comprised of 780 smears positive cases and carried out in SNMC & HSK hospital from Jan2014 to June 2015.Complete blood count of 780 malaria positive cases was studied. Complete blood count was done on automated blood cell analyser and blood smear examination was also done. Observations made in study are summarised as follows- In the present study most common species causing malaria was P.vivax (71.92% of cases) followed by P.falciparum (20%) and mixed vivax and falciparum (8.08%) of cases.Out of 780 cases 718(92.05%) were positive for malaria antigen and positivity was more at moderate and heavy parasitemia than at scanty parasitemia. Majority of the cases were in the age group of 21-30 year (23.85% of all cases). Males were affected more commonly than females. In the present study leucocytopenia (17.95%) was more common abnormality than leucocytosis (5.64%). Leucocytopenia and leucocytosis were observed in P.falciparum cases more commonly than P.vivax and mixed cases. Neutropenia (15.13%) was common observation than neutrophilia (7.43%). Neutropenia was seen more commonly in P.falciparum

than P.vivax and mixed cases while neutrophilia was more common in mixed cases than P. falciparum and P.vivax. Lymphocytosis was seen in 12.56% of all cases of malaria which was more common in P.falciparum than P.vivax and mixed cases. Monocytosis was seen in 8.46 % of all cases and was more common in P.falciparum. In the present study 68.97% of the cases showed anemia. Anemia was more common in P.falciparum cases. 64.49% of all cases showed reduction in red cell count which was more frequently seen in P.falciparum. More than half of the cases showed reduced haematocrit. Mixed cases showed more reduction in haematocrit than P.falciparum and P.vivax. Majority of the cases showed normal red blood cell indices.However reduction in MCV, MCH and MCHC was more common in P.falciparum than P.vivax and mixed cases. Red cell distribution width was increased in 37.18% of all cases. P.falciparum cases showed more frequent increase in RDW. Thrombocytopenia was also common observation seen in 65.90% of all cases which was more commonly seen in P.falciparum. MPV was increased in 27.43% of the cases, P.falciparum showed more common increase in MPV Other platelet indices (PCT, PDW and P-LCR) were normal in majority of the cases. More frequent derangement in these parameters was seen in P.falciparum than P.vivax and mixed cases.

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