Research Article

Assessment of Hematological Parameters among Malaria Patients in River Nile State, Sudan

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ABSTRACT

Background: Malaria, which is responsible for a substantial number of deaths in endemic countries, has been shown to have both direct and indirect effects on the hematological parameters, notwithstanding, some hematological parameters among populations living in malaria-endemic regions have not been described consistently, as a standard for measuring malaria burden. Malaria causes a febrile illness with several changes in blood cell parameters. Some of these changes include leucopenia, thrombocytopenia, and anemia. If these changes could be correlated with the degree of parasitemia, it can serve as a guide to physicians when treating malaria. ***Objectives***: This study was therefore aimed at the assessment of Hematological Parameters among malaria patients in River Nile State, Sudan. ***Methods***: A total of 100 participants were in this study, 50 were malaria patients and 50 were healthy for comparison. The mean age of the study group was 40 and the control group was 45. ***Results***: This study shows total WBCs, lymphocyte, Mixed, unaffected by malaria parasite (*P. value*: 0.753, 0.666, 0.131) respectively, there were significant elevations in neutrophil count (*P. value* 0.04). There was no significant association between RBCs, HGB, HCT, MCV, MCH, MCHC, RDW-SD, RDW-CV, and malaria (*P. value*: 0.409, 0.112, 0.438, 0.698, 0.773, 0.816, 0.355, 0.530) respectively. There was no significant association between PLT, PDW, MPV, PCT, and malaria (*P. value*: 0.894, 0.956, 0.611, 0.902) respectively. ***Conclusion***: This study revealed that routinely used laboratory findings such as hemoglobin, leukocytes, platelet counts, and even red cell distribution width values can provide a diagnostic clue in a patient with acute febrile illness in endemic areas, thus increasing the probability of malaria and enhance prompt initiation of treatment.

***Keywords*:** Malaria, Hematological parameters, leukocytes, Platelet counts.

INTRODUCTION

Malaria is a disease caused by protozoan parasites of the genus *Plasmodium*. The five *Plasmodium* species well known to cause human malaria are; *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae*, and *Plasmodium knowlesi*. *P. falciparum* is responsible for most malaria deaths. The infection can develop suddenly and produce several life-threatening complications **[1].** Globally, about 3.2 billion people live in areas at risk of malaria transmission. An estimated 350–500 million clinical malaria episodes occur annually, mostly caused by infection with *P. falciparum* and *P. vivax*. Malaria causes 1.1–2.7 million deaths each year as a result of severe malaria. It is the fifth cause of death from infectious diseases worldwide, and the second leading cause of death in Africa **[2].** Malaria control was difficult because of drug resistance of the parasite and insecticide resistance of the vector **[3].** Epidemiologically, *P. falciparum* malaria covers 85% of all malaria cases worldwide. It occurs mainly in the hotter and more humid regions of the world and the most pathogenic species. *P. vivax* malaria is the second most important public health problem. It is characterized by the occurrence of malaria relapses due to the re-activation of hypnozoites in the liver cells. Although the complication of *P. vivax* infection is relatively less, rupture of an enlarged spleen occasionally occurs and could be life-threatening **[4,5].** According to a WHO report, almost 90% of all malaria deaths in the world occur in Africa. An estimated one million people in Africa die from malaria each year. The important way to reduce malaria morbidity and mortality is best achieved through early diagnosis and prompt, effective treatment, which is the base for the management of malaria. Microscopy remains the mainstay of parasite-based diagnosis in most health clinics and hospitals; however, the quality of microscopy-based diagnosis is inadequate for ensuring good health outcomes **[6,7].** A recent study among patients with falciparum malaria in West Kordufan state concluded that antimalarial treatment was effective in reverting abnormal blood counts to normal values 2 weeks after the completion of treatment, suggesting the need for treating such patients irrespective of malaria parasite positivity **[8].** Hematological alterations associated with malaria infection may vary depending on the following factors: level of malaria endemicity, background hemoglobinopathy, demographic factors, and malaria immunity. The pathophysiological processes causing the hematological changes in malaria are complex, multiple, and incompletely understood **[9].** The immunological background of *P. falciparum* and *P. vivax* infection do have its

effect on the absolute counts of peripheral blood mononuclear cells and granulocyte subsets. The level of the cytokines TNF-α and IFN-α, which are known to induce the expression of selectins, integrins, and chemoattractant chemokines have been observed to correlate with malaria severity caused by *P. falciparum* and *P. vivax* **[10].** Prediction of the hematological changes in malaria enables the clinician to establish an effective and early therapeutic intervention to prevent the occurrence of major complications. Hematology parameters can help to provide a presumptive treatment, especially when the results of the parasitological examination are not immediately available or are uncertain to decide treatment for malaria **[11-14].** and help to intensively care for the patient and prevent a death that may result from such complications **[15].**

Materials and methods:

Study design:

Descriptive cross-sectional study.

Study area:

Berber teaching hospital, Atbara teaching hospital.

Study population:

Malaria patients in River Nile state.

Data collection:

The primary data was collected by standard questionnaire and the secondary data was analyzed.

Sample size:

The sample size will be 100 people,50 are healthy people with control and the other 50 are patients with malaria.

Data analysis:

Data was analyzed by statistical measurement "SPSS".

Ethical Consideration:

A formal letter From ALSHEIKH ABDALLA ALBADRY UNIVERSITY department of hematology to the medical director of Atbara and Berber Hospital from whom we received written consent to conduct the research also took written consent from the patient themself.

RESULTS

Total of (100) participants in this study, (50) were malaria patients and (50) healthy for comparison. The mean age of the study group was (40) and the control group was (45). This study shows total WBCs, lymphocyte, Mixed, not affected by malaria parasite (*P. value*: 0.753, 0.666, 0.131) respectively, there were significant elevations in neutrophil count (*P. value* 0.04). There was no significant association between RBCs, HGB, HCT, MCV, MCH, MCHC, RDW-SD, RDW-CV, and malaria (*P. value*: 0.409, 0.112, 0.438, 0.698, 0.773, 0.816, 0.355, 0.530) respectively. There was no significant association between PLT, PDW, MPV, PCT, and malaria (*P. value*: 0.894, 0.956, 0.611, 0.902) respectively.

Table 1. Distribution of study group according to sex.

Sex	Frequency	Percent
Male	25	50%
Female	25	50%
Total	**50**	**100%**

Table 2. Distribution of study group according to white cell count.

WBCS	Frequency	Percent
Less than 4	7	14%
4 - 11	35	70%
More than 11	8	16%
Total	**50**	**100%**

Table 3. Distribution of study group according to lymphocyte count

Lymphocyte count	Frequency	Percent
Less than 20	17	34%
20 - 40	17	34%
More than 40	16	32%
Total	**50**	**100%**

Table 4. Distribution of study group according to neutrophil count

Neutrophil count	Frequency	Percent
Less than 40	11	22%
40 - 75	24	48%
More than 75	15	30%
Total	**50**	**100%**

Table 5. Distribution of study group according to mixed cell count

MXD	Frequency	Percent
Less than 3	3	6%
3 - 19	47	94%
More than 19	0	0%
Total	**50**	**100%**

Table 6. Distribution of study group according to red blood count for male & female

RBCS for male	Frequency	Percent
Less than 4.5	7	28%
4.5 - 6.5	18	72%
More than 6.5	0	0%
Total	**25**	**100%**

Table 7. Distribution of study group according to red blood count for male

RBCS for female	Frequency	Percent
Less than 4.0	4	16%
4.0 - 5.5	20	80%
More than 5.5	1	4%
Total	**25**	**100%**

Table 8. Distribution of study group according to hemoglobin count for female

Hb for female	Frequency	Percent
Less than 12	10	40%
12 – 15	14	56%
More than 15	1	4%
Total	**25**	**100%**

Table 9. Distribution of study group according to hemoglobin count for male

Hb for male	Frequency	Percent
Less than 13	14	56%
13 – 16	11	44%
More than 16	0	0%
Total	**25**	**100%**

Table 10. Distribution of study group according to hematocrit for male

HCT for male	Frequency	Percent
Less than 40	18	72%
40 – 50	7	28%
More than 50	0	0%
Total	**50**	**100%**

Table 11. Distribution of study group according to hematocrit for female

HCT for male	Frequency	Percent
Less than 37	16	64%
37 – 47	9	36%
More than 47	0	0%
Total	**50**	**100%**

Table 12. Distribution of study group according to mean cell volume

MCV	Frequency	Percent
Less than 80	29	58%
80 – 100	21	42%
More than 100	0	0%
Total	**50**	**100%**

Table 13. Distribution of study group according to mean cell hemoglobin

MCH	Frequency	Percent
Less than 27	20	40%
27 – 32	29	58%
More than 32	1	2%
Total	**50**	**100%**

Table 14. Distribution of study group according to mean cell hemoglobin concentration

MCHC	Frequency	Percent
Less than 33	12	24%
33 – 36	25	50%
More than 36	13	26%
Total	**50**	**100%**

Table 15. Distribution of study group according to red blood cell distribution width

RDW-SD	Frequency	Percent
Less than 39	9	18%
39 – 45	24	48%
More than 45	17	34%
Total	**50**	**100%**

Table 16. Association between WBCS control and cases

WBCS	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	5.868	5.800	0.8883	3.0	4.0	7.0
Cases	7.200	5.900	3.3878	13.5	1.4	14.8

Table 17. Association between LYM control and cases

LYM	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	33.464	34.600	6.3303	25.2	19.7	44.9
Cases	29.991	27.550	16.7270	67.5	0.4	67.9

Table 18. Association between NEUT control and cases

NEUT	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	55.532	54.400	7.9223	31.3	40.7	72.0
Cases	60.792	61.650	17.8074	62.6	26.1	88.7

Table 19. Association between MXD control and cases

MXD	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	10.306	10.000	3.6885	16.8	3.1	19.9
Cases	8.369	7.700	4.0374	16.6	1.3	17.8

Table 20. Association between RBCs control and cases

RBCs	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	4.8257	4.7200	0.45500	1.80	4.00	5.80
Cases	4.5032	4.6050	0.57517	2.64	3.03	5.67

Table 21. Association between HGB control and cases

HGB	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	14.142	14.200	1.1775	4.7	12.0	16.7
Cases	12.334	12.450	1.9166	10.2	16.8	6.6

Table 22. Association between HCT control and cases

HCT	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	41.242	40.800	3.3099	12.3	35.3	47.6
Cases	35.362	35.650	5.3220	25.9	19.5	45.4

Table 23. Association between MCV control and cases

MCV	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	84.792	84.100	3.9015	18.7	77.2	95.9
Cases	78.614	78.300	6.7193	34.7	59.5	94.2

Table 24. Association between MCH control and cases

MCH	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	29.202	28.900	1.4703	7.3	26.8	34.1
Cases	27.370	27.750	2.9346	15.9	21.0	36.9

Table 25. Association between MCHC control and cases:

MCHC	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	34.538	34.750	1.0757	5.7	32.1	37.8
Cases	34.938	34.450	4.0054	22.8	27.5	50.3

Table 26. Association between RDW-SD control and cases

RDW-SD	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	42.014	42.100	2.3017	13.0	32.0	45.0
Cases	42.606	42.050	3.6010	14.6	36.1	50.7

Table 27. Association between RDSW-CV control and cases

RDSW-CV	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	13.008	13.050	0.6308	2.4	14.0	11.6
Cases	14.340	14.250	1.5502	9.1	10.5	19.6

Table 28. Association between PLT control and cases

PLT	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	300.38	288.00	58.691	212	210	422
Cases	251.22	259.50	100.085	429	49	478

Table 29. Association between PDW control and cases

PDW	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	11.260	11.100	1.1240	4.5	9.0	13.5
Cases	13.846	15.150	2.2201	7.9	9.1	17.0

Table 30. Association between MPV control and cases

MPV	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	7.892	8.050	0.6580	2.9	6.1	9.0
Cases	9.000	9.100	1.3106	5.3	6.5	11.8

Table 31. Association between PCT control and cases

PCT	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Control	0.2818	0.2800	0.04993	0.16	0.20	0.36
Cases	0.2172	0.2200	0.07905	0.35	0.04	0.39

DISCUSSION

Malaria is a major public health problem in Sudan, where it accounts for more cases of infection and deaths than most other countries in the world. USEN reported that malaria affects 3.3 billion people, or half of the world's population in 106 countries and territories.

The hematological values may lead to an increased clinical suspicion for malaria, thus initiating a prompt institution of specific therapy even in the absence of a positive smear report for malaria. A variety of hematological alterations like progressively increasing anemia, thrombocytopenia, leukocytosis or leukopenia have been reported in cases of malaria **[16].**

Lower mean values for hemoglobin, leukocyte count and platelet count in the malaria group compared to the control group was observed in our study. This was in concordance with other studies **[16,17].** The present study demonstrated that different hematological variables (Hb, RBCS indices, RDW, Platelets) increase the probability of malaria. Anemia is known to be associated with malaria in endemic areas, although malaria may not be the prime cause of it **[18].** The present study demonstrates that low Hb is a increases the probability of malaria. However, sensitivity and specificity were low in the diagnosis of malaria in our study, this was in concordance with the results of Lathia et al. **[17].**

The pathogenesis of anemia in malaria is complex and multifactorial. Although not completely understood, it is often thought to result from a combination of hemolysis of parasitized red blood cells, accelerated removal of both parasitized and unparasitized red blood cells, depressed as well as ineffective erythropoiesis with dyserythropoietic changes, and anemia of chronic disease **[19,20].** Other contributing factors may include decreased red blood cell deformability, splenic phagocytosis and/or pooling, leading to an increased rate of clearance from the circulation **[20].**

Leucopenia is a common finding in malaria cases although leukocytosis is also seen. Leucopenia 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 **[21].** Our study related leucopenia as a statistically significant variable in malaria, in concordance with other reports **[17,22].**

Recently however, a study found leukocyte in malaria which is at variance with our findings, while others have reported normal TLC in malaria cases **[22,23].** The differential WBC showed a normal neutrophil count in the majority of cases (mean=60.7%) in concordance with some, **[20]** and differing from other studies, which reported either neutropenia or neutrophilia among malaria cases **[24].**

Lymphopenia and the presence of reactive lymphocytes have been reported to often mimic a viral infection, **[20].** however, the present study reported normal lymphocyte count. Similarly, monocytosis has been reported to occur, although the present study showed that the majority of malaria patients had a low mean monocyte count **[20,24].**

Red cell distribution width (RDW) along with mean corpuscle volume (MCV) of red cells have appeared as new parameters to be studied in malaria. RDW describes the population dispersion of red cell volume or the range of changes in size of red blood cells which mostly present as enlarged after malarial invasion **[16].** In the present study RDW, values were found to be higher in the malaria group than the non-malarial cases in concordance with other study findings, **[16]** however this was in contrast to the findings of Lathia etal **[17].** The opinions of authors differ on the sensitivity and specificity of RDW in malaria diagnosis, while some consider high RDW a poor marker, **[17]** others do not **[16].** Although the role of RDW in the diagnosis of malaria is debatable, the presence of increased RDW has correlated well with the percentage of macrocytes in one study **[25]** hence a combination of RDW and MCV may be more helpful.

Conclusion:

Hematological investigation is relatively inexpensive and a less technically sophisticated way for malaria parasite detection. hematological parameters of malaria infected patients significantly differ from that of healthy uninfected individuals. The mean values of hematological parameters of malaria infected males are significantly different from those of their female counterparts. The present study has demonstrated that the hematological parameters are reliable and competent measures to diagnose severity of malaria infection, even at the early stages. In this study, the Mean values of hematological parameters were significantly different in the malaria groups than the controls. Therefore, prediction of the hematological changes enables the clinician to establish an effective and early therapeutic intervention in order to prevent the occurrence of major complications. This may be used in addition to the clinical and microscopic parameters to heighten the suspicion of this disease and prompt initiation of the treatment. Further longitudinal study should be conducted to identify the cause effect relationships. Researchers that are going to be done for the future will be also better if the nutritional statuses of the patient, large sample size and cell morphology are included.

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Conflict of Interest:

The author has affirmed that there are no conflicting interests.

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