ORIGINAL ARTICLE

Comparison of Haematological and Biochemical Parameters in Malaria and Normal subjects

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ABSTRACT

Background: Malaria is quite well known for causing high morbidity and mortality rate throughout the world. There is a dire need to improve diagnostic approach towards the disease.
Aim: To assess biochemical and hematological changes in malarial patients.
Methods: The controlled trial study was performed from 1st May 2017 to 1st May 2018 at Shaikh Zayed Hospital Lahore, Pakistan. The blood samples were collected from 300 patients and evaluated for various biochemical and hematological alterations.
Results: The malarious patients showed significant alterations as compared to non-malarious patients in both the biochemical and haematological indices.
Conclusion: The biochemical and haematological tests can be used for early and effective diagnosis of malaria.
Key words: Diagnosis, Malaria, Haematological indices, Morbidity, Mortality

INTRODUCTION

The term 'malaria' is derived from Italian language and originates due to foul air near marshy regions. Malaria is considered as an important communicable disease throughout the world. It is highly prevalent in subtropical and tropical areas and causes high mortality rate[1]. Each year, 300 to 500 million people get infected with malaria, out of which 1.5 to 2.7 million individuals die. At present more than 100 countries are considered malicious for malaria with 2.4 billion people at risk of disease throughout the world[2].

The protozoan species of Plasmodium genus causes malaria, including *P. malariae, P. ovale, P. vivax, P. falciparum* and *P. knowlesi*. The parasite utilizes female Anopheles mosquito to complete sexual cycle, from where sporozoites invade human body and causes disease.[3]. They enter liver and red blood cells, leading towards pyrexia, sweating, shivering and spleen enlargement. Malaria transmission occurs through blood transfusion, congenital transmission and sharing of needles[4].

The blood can be regarded as a tissue which keeps circulating in blood vessels. It consists of solid components including white blood cells, platelets, red blood cells, and liquid suspension of plasma[5]. Thus, plasma fluid is extracellular in nature and incarcerates in the vascular system. Other components of plasma include metabolites, electrolytes, nutrients, water, proteins and hormones[6]. Although physiochemical indices of blood remain uniform, varying tendency may occur during different physiological conditions. During a pathophysiological situation such as genetic disorders, malnutrition, malignancy and infections, the internal part of blood system depicts alterations and deformations. In both *P. falcipum* and *P. vivax*, physiochemical parameters have been reported to alter with malarial endemicity, malarial immunity, nutritional status, demographic factors and presence of haemoglobinopathies[7]

The previous research works have shown that malarial patient witnesses haematological and biochemical changes. Haematologic changes linked with malaria include monocytosis, neutrophilia, leucopenia, thrombocytopenia, anaemia, eosinophilia, lymphocytosis and disseminated intravascular[8]. By assessing alteration in blood parameters, clinicians are enabled to properly diagnose and deduce reliable therapeutic interventions[9]. According to World Health Organization (WHO), severe malaria can be suspected on the basis of biochemical and haematological alterations[10]. Thus, the present study investigates the biochemical and hematological alterations brought about by malaria parasite. This would help in understanding pathogenesis of malaria and help with diagnosis and management of the disease. The therapeutic interventions for the disease can also be easily deduced as pathogenesis of malaria depends on biochemical and haematological parameters.

MATERIALS AND METHODS

The present study was performed from 1st May 2017 to 1st May 2018 at Sh. Zayed Hospital Lahore. The patients with gastrointestinal infection, renal issues, protein energy malnutrition, hepatitis obstructive jaundice, cirrhosis, cancer, hypertension, diabetes, obesity, HIV, alcoholism, and smoking were excluded from the study. Moreover, people on vitamin supplements, anti-malaria drugs or treatment for malaria were also excluded. 5 ml of blood samples were collected from 300 fasting patients by venipuncture in EDTA tube (2.5 ml) and plain tubes (2.5 ml). The samples were tested for rapid malarial antigen and microscopic examination through preparation of thick and thin smear. All the patients were given explanation about the study and written consents were collected from them.

The blood samples collected in plain tubes were centrifuged at 4000 rpm for 10 min by Laboratory centrifuge after clotting. The serum was separated and collected in serum cups for renal function test and liver function test. Complete blood count was done by Sysmex KX-21 haematology analyzer. Coagulation analysis was done by

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Sysmex Coagulation analyzer CA-600 series. For assessment of erythrocyte sedimentation rate (ESR), westergrens tube[11] method was followed.

Fasting blood sugar was done on automated chemistry analyzer. Serum urea, creatinine levels, alanine aminotransferase and albumin concentration were estimated by SELECTRA XL chemistry automated analyzer[12,13]. The statistical analysis was conducted through chi square test on SPSS-20.

RESULTS

Table 1 showed comparative biochemical indices for malarious and non-malarious groups. A significant difference was not present between the two groups with $p<0.05$ for serum albumin and creatinine. For both serum albumin and creatinine, the values were within the reference interval of 3.5-5.5 and 0.7-1.5. The concentrations for albumin and creatinine in malarious patients were 4.54±0.03, 4.23±0.09 and 0.89±0.21, 1.24±0.13. The serum urea concentrations were significantly higher in malarious group as compared to non-malarious one with $p<0.05$. It was 18.38±0.34 for males and 21.32±0.14 for females. The serum FBS was higher in non-malarious individuals as compared to malarious ones. In malarious males it was 64.23±1.28 for males and 65.38±0.09 for females.

The haemotological indices for the malarious and non-malarious individuals are mentioned in the Table 2. The values for non-malarious subjects were within reference intervals with significant difference from malarious patients ($p<0.05$). The haemoglobin concentrations for malarious group were 12.23±0.21 g/dL and 11.21±0.27 g/dL, as compared to non-malarious group having 14.22±0.93 g/dL and 15.11±0.98 g/dL concentration. The value for ESR of malarious group (30.34 ± 0.65 mm/h, 29.31±0.34 mm/h) was higher than the reference interval 0-15 mm/h. The non-malarious individuals had significantly different values ($p<0.05$) of ESR from malarious group. The PCV of malarious group was below the reference level of 40-54 %. It was 30.10±0.38% for males and 29.35±0.71% for females. Though WBC level was within reference level of 4.5-11.0, it was higher in malarious group (14.23±4.23, 12.11±5.23) as compared to non-malarious. We observe PT values were higher than the normal range and higher as compared to the non-malarious group it was 13.60±1.65 and 13.22±1.96. APTT values in malarious group in males and females were noted as 38.11±1.48 and 37.85±1.49 and in non malarious group was 31.04±1.74 and 30.99±1.79 in males and females respectively. We noted platelets values in malarious and non-malarious groups in both genders were 74.07±14.91, 76.03±25.63 and 319.31±84.29, 311.89±87.60 respectively shown in Table 2.

Table 1: Biochemical parameters

Parameters	Normal range	Malarious individuals		Non-Malarious individuals	
		Male	Female	Male	Female
Albumin	3.5-5.5 $\times10^3$	4.54±0.03	4.23±0.09	5.13±0.04	4.76±0.22
Creatinine	0.7-1.5 md/dL	0.89±0.21	1.24±0.13	0.75±0.15	0.85±0.34
Urea	8-20 mg/dL	18.38±0.34	21.32±0.14	11.21±0.38	13.22±0.33
FBS	60-100 mg/dL	64.23±1.28	65.38±0.09	84.35±1.11	88.28±1.21

Table 2: Haematological parameters

Parameters	Normal range	Malarious individuals		Non-Malarious individuals	
		Male	Female	Male	Female
Hb	13.5-18 (g/qdL)	12.23±0.21	11.21±0.27	14.22±0.93	15.11±0.98
ESR	0-15 mm/h	30.34±0.65	29.31±0.34	14.23±0.56	15.22±0.87
PCV	40-54%	30.10±0.38	29.35±0.71	33.23±0.60	32.45±0.12
WBC	4.5-11 $\times10^3$	14.23±4.23	12.11±5.23	4.33±2.34	5.26±5.34
PT	11-13.5 Sec	13.60±1.65	13.22±1.96	9.542±1.04	9.46±0.94
APTT	30-40 Sec	38.11±1.48	37.85±1.49	31.04±1.74	30.99±1.79
Platelets	150-450 $\times10^9$/L.	74.07±14.91	76.03±25.63	319.31±84.29	311.89±87.60

DISCUSSION

The literature has widely reported haematologic and biochemical changes associated with malaria infection. The present study has compared haematological and biochemical changes in malarious and non-malarious individuals. The haemoglobin levels were observed to be decreased in malarious patients as compared to non-malarious individuals. The same has been advocated by previous research works of Maina et al[14]. Malarial infection causes decrease in concentration of haemoglobin, platelets, red blood cells and cause anaemia. The National Guidelines for Diagnosis, Treatment and Prevention of Malaria For health workers in Kenya has defined anaemia as [Hb]<10 g/dL, whereas, severe anaemia refers to [Hb]<5 g/dL with hyperparasitaemia (>200,000 parasites/µL). The decrease in haemoglobin due to malaria resulted in mild anaemia. On the other hand, PCV levels were observed to be very low in malaria patients. This is justified under the research works of Ogbodo et al[15], and Kayode et al[16]. The anaemia results from increased haemolysis based on pathophysiology of malaria and decrease in haemoglobin production due to decreased level of immunity and nutrition in patient[17].

The increased levels of ESR have been reported in various chronic and acute infections, inflammatory diseases, necrosis and pregnancy. Previously ESR levels have been used for diagnosing and monitoring of remedial interventions for malaria. Consequently, it has been indicated that ESR levels increase in malarial infection, whereas, it decreases with recovery from the disease. Thus, the results of present study are justified under previous research work of Sumbele et al[18]. Malarial

patients tend to have lower count for white blood cells. In the present study white blood cells in malarial patients was increased. However, leukocytosis was not exhibited by malarious individuals, which refers to WBC more than 17,000/µL. Kayode et al[16] found increase in WBC from malarial infection. The reason postulated for this change is the enhanced production of leukocytes at the initial stage of infection to remove parasites of malaria from body. Similarly, WBC has been noted to increase in pregnant as well as non pregnant malaria patients by previous research work of Sumbele et al[18]. However, a previous study showed that both increasing and decreasing tendencies of WBCs can be witnessed[19]. Thus, the use of WBC as a diagnostic marker for malaria is not a reliable approach.

In the present study, haematological parameters in malarial patients were compared on the basis of genders. The haematological indices such as PCV, ESR, and WBC, PT, APTT and platelets, which are diagnostic for malaria infection, We observed that PT values were higher than the normal range and higher as compared to the non-malarious group it was 13.60±1.65 and 13.22±1.96. APTT values in malarious group in males and females were noted as 38.11±1.48 and 37.85±1.49 and in non malarious group was 31.04±1.74 and 30.99±1.79 in males and females respectively. We noted platelets values in malarious and non-malarious groups in both genders was 74.07±14.91, 76.03±25.63 and 319.31±84.29, 311.89±87.60 respectively shown in Table 2 were found to be significantly higher for male counterparts as compared to females. These results are in accordance with previous research works.

Many previous researches have anticipated using albumin levels as a biochemical marker for diagnosis of severe consequences of infection and malnutrition[20]. Amah et al[21] found that serum levels of albumin decreases significantly in malarial patients of Nigeria. The same was found by Kwena et al[20] in patients with malnutrition and pregnancy. The recovery of albumin level in malarial patients depends on hepatic functionality and nutritional status of the patient. Ogbodo et al[15] mentioned that the serum level depends inversely on severity of malaria. Thus, albumin can be used as a substitute of colloidal solutions as an effective intervention in moderate to severe malaria.

The nitrogenous substances like creatinine and urea are important in determination of renal functionality. Renal dysfunction is quite common in cases of severe malaria. In the present study, increase in both creatinine and urea levels is evident in malarious patients.[22] Moreover, levels for both substances increased in same patients. The serum urea level also alters due to tissue catabolism, dehydration and intake of protein based diet. However, in present study, change in nitrogenous levels of malarious patients represented fluctuation of nitrogen metabolism and renal functionality. The alteration in urea concentration represents development of renal dysfunctionality. Thus, urea concentration may alter rapidly as compared to creatinine levels in malarious patients.

Many research works have pointed out towards changing blood sugar levels in malarious patients. According to Kayode et al[16], hypoglycemia occurs in the patients of malaria. In an infection, the secretion of insulin is stimulated depending on the severity of infection. Onyesom and Oyenakamor[5] found that hypoglycemia is highly prevalent among malarial patients of Edo-Delta state. Previous research works have widely reported low levels of glucose and insulin like growth factor (IGF-1) in malarious patients[23]. The hypoglycemia increases with progress in malarial infection due to insufficient production of glucose based on host and parasite demand. Thus, the hypoglycemia witnessed in present study has been supported by previous research works of Kayode et al[16] and Onyesom and Oyenakamor[5]. Previous research works have indicated that biochemical parameters of *P. falaciparum* are more affected as compared to *P. vivax*.

The present study affirms the haematological and biochemical alterations in malarial patients. This study is an effort to extend the efforts of understanding changes in blood profile of malaria patients in Lahore. The haematological and biochemical changes in malarial patients can act as a diagnosis tool for early detection of malaria. The complications caused by severe malarial infection can be diagnosed and overcome at right time. This can help in coping up with the morbidity and mortality rate caused by the disease.

The methods of biochemical and haematological analysis are simpler than cell blood count through automatic analyzers, which have less availability in many countries. In such a scenario both these methods can be used as an effective diagnostic tool, especially in developing countries. However, it is recommended that differential parameters of genders should be undermined while implementing diagnostic tests.

The tests of haemotological and biochemical analysis can be helpful in management of malaria at locations where there is a lack of appropriate facilities and laboratory workers. Anyhow, extensive research is required to evaluate reliability of haematological and biochemical diagnostic tools at different time intervals, after the infection. This will help in assessing the efficiency of these diagnostic tools in detecting malaria on early time basis.

CONCLUSION

The disease of malaria is well known for high mortality and morbidity. This can be reduced by diagnosing malaria at early stages through various biomarkers. Consequently, biochemical and haematological parameters can be regarded as efficient biomarkers in appropriate diagnosis of malaria. Moreover, it can also be used to differentiate between the causative agents of the disease. The present study has shown that malarial infection imparts great effect on biochemical and haematological indices of the patient. Both of these diagnostic methods are cost effective in nature and less sensitive way for detection of malaria parasite. Moreover, they have high reliability with competitiveness to diagnose malaria with accuracy at early stages. Thus, both of them can be used for differential diagnosis of patients with complications such as hepatomegaly and spleenomegaly.

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