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Biochemical and Hematological Changes Associated With Malaria and Intestinal Parasite Infections

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Abstract

Human parasitic infections are endemic in all developing countries including India. Parasitic infections significantly alter various biochemical and haematological parameters and are responsible for considerable mortality and morbidity. The aim of this study was to compare the biochemical and haematological parameters induced by various human parasitic infections. Stool samples were examined for ova and cysts to detect the intestinal parasites and malaria parasites were detected by thin and thick smear. Biochemical and haematological studies were performed on parasite-positive patients. The parameters observed were analysed by Student's 't' test. P value < 0.05 was considered significant. Statistical analysis showed that serum protein and albumin levels were significantly decreased in patients with ancylostomiasis and malaria. Patients of malaria parasites revealed significantly increased levels of serum ALP, total bilirubin, direct bilirubin, SGPT and SGOT. Significant increase in eosinophils percentage level was observed in patients with ascariasis, ancylostomiasis and taeniasis. Haematological study of patients with ancylostomiasis and malaria showed significant decrease in haemoglobin, RBCs and PCV levels. Apart from the above, platelets and total leukocytes were also found to be significantly decreased in malaria patients. This study shows that parasitic infection alters biochemical and haematological parameters. Hence, educating the population, promoting good hygiene practices and using deworming services as needed would be helpful in preventing the spread of malaria and intestinal parasitic infections.

Keywords*:* Intestinal parasites, malaria, biochemical alteration, hemoglobin, Albumin.

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Introduction

It is well known that malaria and intestinal parasites induce several biochemical and haematological parameters. Malaria is an infectious disease caused by protozoan parasites of the genus *Plasmodium* and transmitted by female Anopheles mosquitos (WHO 2019). Based on the World Health Organization (WHO, 2020), malaria caused 627,000 deaths and 241,000,000 cases globally in 2020 (Kim *et al*. 2008). Malaria parasites go through a hepatocyte developmental stage. Sporozoites produced from the salivary gland of a mosquito must effectively target and penetrate hepatocytes (Hänscheid *et al*. 2008). *Plasmodium falciparum* malaria frequently causes life-threatening complications such as hepatic dysfunction, jaundice, and severe anaemia (Kimbi *et al*. 2013). Intestinal parasitic infection induces the several abnormalities in haematological and biochemical parameters. Intestinal parasitic infection significantly decreased the level of haemoglobin and Packed Cell Volume (PCV) values (Demeke *et al*., 2021). Increasing hookworm infection intensity is associated with lower haemoglobin levels in pregnant women (Brooker *et al*., 2008). Indeed, intestinal parasitic infections, mostly helminths have been linked with an increased risk for nutritional anaemia, protein-energy malnutrition and growth deficits in children, low pregnancy weight gain and intrauterine growth retardation followed by low birth weight (Rodriguez-Morales *et al*., 2006 and Sackey *et al*., 2003). The frequency and incidence of human parasitic diseases varies with various factors like geography, rainy season, education level of population etc. The aim of the present study was to evaluate biochemical and haematological parameters to determine the adverse effects of infection and to aid in the diagnosis and treatment of patients suffering from parasitic diseases.

Materials and Methods

In the present study, potential patients with parasitic diseases were screened from among the participants using the symptoms and signs of parasitic diseases. All screened participants were then examined by the relevant standard methods for detection of parasitic infection. Informed and written consent was obtained from all participants and, in the case of minor participants from their parents. Confidentiality was ensured by keeping participants identity confidential. To execute the study of intestinal parasitic infection, clinical symptoms, and sign of intestinal parasitic disease like abdomen pain, constipation, diarrhea, more than two stool passing in a day and offensive stool were considered as primary diagnostic tools to enhance the value of estimation. Participants with the above clinical features were given a sterilized screw capped containers of 50 ml capacity to collect the stool samples. Stool samples were examined by stool microscopic examination for ova and cyst (Fleck and Moody, 1993 and Garcia, 2016). To study of malaria parasite infection, clinical symptoms, and signs of malaria infection such as hyperpyrexia with chills and hyperpyrexia occurring every second day or every third day were considered as the primary diagnostic tool to enhance the value of the assessment. Participants with the above clinical symptoms were further examined by thin and thick peripheral blood smear examination. The smears were stained with Leishman

and Field stain and studied through 100x oil immersion lens (Fleck and Moody, 1993). Participants who tested positive for intestinal parasitic infection and malaria in the final diagnosis were included in the study. To make the study easy, 6 groups were created according to the parasitic diseases in which Group-1 was created for control and Group-2, Group-3, Group-4, Group-5 and Group-6 were created for ascariasis, amoebiasis, ancylostomiasis, taeniasis and malaria respectively. For biochemical and hematological studies, five patients each were selected for each parasitic disease. Blood samples about 4.5 ml were collected from all selected patients using standard aseptic venipuncture techniques in EDTA, sodium fluoride and plain vacutainers.

Biochemical Study: Serum protein, serum albumin, serum globulin, serum bilirubin total, serum direct bilirubin, serum indirect bilirubin, serum alkaline phosphatase (ALP), serum glutamic pyruvic transaminase (SGPT), serum glutamic oxaloacetic transaminase (SGOT), serum creatinine, serum urea, serum glucose and serum cholesterol were analysed by using biochemistry analyser by standard End point and Enzymatic methods in all parasitic positive patients and control group.

Haematological Study: Haemoglobin by Cyanmethemoglobin method, red blood cells (RBC) count by Haemocytometer, Total Leucocyte Count (TLC) by Haemocytometer, Platelet count by Haemocytometer, Packed Cell Volume (PCV) by Wintrobe tube method, Differential Leucocyte Count (DLC) by peripheral blood smear study and erythrocyte sedimentation rate (ESR) by Wintrobe tube method in all parasitic positive patients along with control group.

Statistical analysis: Haematological and biochemical parameters were analysed by student 't' test. p value < 0.05 was considered as significant.

Results:

To describe the results of the present study in a simple manner, the results have been divided into two main headings, biochemical observations, and hematological observations. The results of all parasitic diseases were described according to their respective groups.

Biochemical study

Group-1. Control:- Biochemical study of control group (Group-1) revealed the mean value of total serum protein, albumin and globulin to be 7.03 gm/dl, 4.01 gm/dl and 3.02 gm/dl respectively. The mean value of total bilirubin, direct bilirubin and indirect bilirubin were observed to be 0.66 mg/dl, 0.24 mg/dl and 0.42 mg/dl respectively. Enzyme study showed the mean value of serum ALP, SGPT and SGOT to be 87.8 IU/L, 22.4 IU/L and 22.6 IU/L respectively. The mean value of serum creatinine and serum urea were detected to be 0.76 mg/dl and 22.2 mg/dl respectively. Mean value serum glucose and serum cholesterol were examined to be 103.8 mg/dl and 183.0 mg/dl respectively (Table-1 to table-5).

Group-2. Ascariasis: Biochemical study of group-2 showed the mean value of total serum protein, albumin and globulin to be 6.86 gm/dl, 4.0 gm/dl and 2.86 gm/dl respectively. The mean value of total bilirubin, direct bilirubin and indirect bilirubin were observed to be 0.70 mg/dl, 0.26 mg/dl and 0.44 mg/dl respectively. Enzyme study showed the mean value of serum ALP, SGPT and SGOT to be 93.6 IU/L, 33.4 IU/L and 27.0 IU/L respectively. The mean value of serum creatinine and serum urea were detected to be 0.82 mg/dl and 24.0 mg/dl respectively. Mean value serum glucose and serum cholesterol were examined to be 105.8 mg/dl and 179.2 mg/dl respectively (Table-1 to table-5).

Group-3. Amoebiasis:- Biochemical study of group-3 revealed the mean value of total serum protein, albumin and globulin to be 6.86 gm/dl, 3.84 gm/dl and 3.04 gm/dl respectively. The mean value of total bilirubin, direct bilirubin and indirect bilirubin were observed to be 0.78 mg/dl, 0.28 mg/dl and 0.50 mg/dl respectively. Enzyme study showed the mean value of serum ALP, SGPT and SGOT to be 87.2 IU/L, 33.6 IU/L and 24.2 IU/L respectively. The mean value of serum creatinine and serum urea were detected to be 0.80 mg/dl and 25.20 mg/dl respectively. Mean value serum glucose and serum cholesterol were examined to be 103.4 mg/dl and 172.2 mg/dl respectively (Table-1 to table-5).

Group-4. Ancylostomiasis:- Biochemical study of group-4 revealed the mean value of total serum protein, albumin and globulin to be 6.20 gm/dl, 3.44 gm/dl and 2.76 gm/dl respectively. The mean value of total bilirubin, direct bilirubin and indirect bilirubin were observed to be 0.78 mg/dl, 0.30 mg/dl and 0.48 mg/dl respectively. Enzyme study showed the mean value of serum ALP, SGPT and SGOT to be 99.8 IU/L, 34.4 IU/L and 25.6 IU/L respectively. The mean value of serum creatinine and serum urea were detected to be 0.86 mg/dl and 23.8 mg/dl respectively. Mean value serum glucose and serum cholesterol were examined to be 112.0 mg/dl and 166.4 mg/dl respectively. Statistical analysis showed that there was a significant decrease ($P<0.05$) in serum protein and albumin levels in the patients of ancylostomiasis (Table-1 to table-5).

Group-5. Taeniasis:-Biochemical study of group-5 revealed the mean value of total serum protein, albumin and globulin to be 6.92 gm/dl, 3.92 gm/dl and 3.0 gm/dl respectively. The mean value of total bilirubin, direct bilirubin and indirect bilirubin were observed to be 0.76 mg/dl, 0.26 mg/dl and 0.50 mg/dl respectively. Enzyme study showed the mean value of serum ALP, SGPT and SGOT to be 103.2 IU/L, 32.2 IU/L and 29.6 IU/L respectively. The mean value of serum creatinine and serum urea were detected to be 0.88 mg/dl and 22.8 mg/dl respectively. Mean value serum glucose and serum cholesterol were examined to be 99.0 mg/dl and 157.0 mg/dl respectively (Table-1 to table-5).

Group-6. Malaria:- Biochemical study of group-6 revealed the mean value of total serum protein, albumin and globulin to be 6.92 gm/dl, 3.68 gm/dl and 3.24 gm/dl respectively. The mean value of total bilirubin, direct bilirubin and indirect bilirubin were observed to be 1.33 mg/dl, 0.50 mg/dl and 0.88 mg/dl respectively. Enzyme study showed the mean value of serum ALP, SGPT and SGOT to be 122.8 IU/L, 43.0 IU/L and 38.0 IU/L respectively. The mean value of serum creatinine and serum urea were detected to be 0.86 mg/dl and 23.8 mg/dl respectively. Mean value serum glucose and serum cholesterol were examined to be 102.6 mg/dl and 176.0 mg/dl respectively. Statistical analysis showed that there was a significant decrease ($P<0.05$) in serum albumin levels and significant elevation ($P<0.05$) in the level of total bilirubin, direct bilirubin, indirect bilirubin, serum ALP, SGPT and SGOT in the patients of malaria parasite (Table-1 to table-5).

Table-1. Serum protein, albumin and globulin level of subjects suffering from parasitic diseases

Group	Serum Protein Total (gm/dl)	Serum Albumin (gm/dl)	Serum Globulin (gm/dl)

Control	7.03±0.06	4.01±0.04	3.02±0.04
Ascariasis	6.86±0.07	4.00±0.07	2.86±0.12
Amoebiasis	6.86±0.07	3.84±0.07	3.04±0.07
Ancylostomiasis	*6.20±0.18[1]	*3. 44±0.18[2]	2.76±0.18
Taeniasis	6.92±0.14	3.92±0.07	3.00±0.08
Malaria	6.92±0.06	*3.68±0.12[3]	3.24±0.14

Results are expressed as mean ± S.E. (n=5)

*Values are significantly different from control (P<0.05P

[1]P=0.0021, t= 4.4482, d.f. =8 [2]P=0.0138, t= 3.140, d.f. =8

[3]P=0.0344, t= 2.5455, d.f. =8

Table-2. Serum Bilirubin total, direct and indirect level of subjects suffering from parasitic diseases

Group	Serum Bilirubin Total (mg/dl)	Serum bilirubin Direct (mg/dl)	Serum bilirubin indirect (mg/dl)
Control	0.66±0.05	0.24±0.02	0.42±0.05
Ascariasis	0.70±0.03	0.26±0.02	0.44±0.02
Amoebiasis	0.78±0.04	0.28±0.04	0.50±0.03
Ancylostomiasis	0.78±0.05	0.30±0.03	0.48±0.04
Taeniasis	0.76±0.05	0.26±0.02	0.50±0.05
Malaria	*1.38±0.17[1]	*0.50±0.08[2]	*0.88±0.09[3]

Results are expressed as mean ± S.E. (n=5)

*Values are significantly different from control (P<0.05P

[1]P=0.0035, t= 4.0893, d.f =8 [2]P=0.0175, t= 2.9824, d.f. =8

[3]P=0.0017, t= 4.640, d.f. =8

Table-3. Serum ALP, SGPT and SGOT level of subjects suffering from parasitic diseases

Group	Serum ALP (IU/Ll)	SGPT (IU/L)	SGOT (IU/L)
Control	87.80±14.16	22.40±2.06	22.60±1.21
Ascariasis	93.60±4.99	33.40±4.62	27.00±3.13
Amoebiasis	87.20±3.83	33.60±4.79	24.20±1.50
Ancylostomiasis	99.80±7.50	34.40±6.31	25.60±2.66
Taeniasis	103.20±11.95	32.20±5.53	29.60±3.19
Malaria	*122.8±4.18[1]	*43.00±6.42[2]	*38.00±5.86[3]

Results are expressed as mean ± S.E. (n=5)

*Values are significantly different from control (P<0.05)

[1]P=0.0452, t= 2.3701, d.f. =8 [2]P=0.0157, t= 3.0553, d.f. =8

[3]P=0.0323, t= 2.5861, d.f. =8

Table-4. Serum Creatinine and Urea level of subjects suffering from parasitic diseases

Group	Serum Creatinine (mg/dl)	Serum Urea(mg/dl)
Control	0.76±0.05	22.20±1.36
Ascariasis	0.82±0.08	24.0±1.41
Amoebiasis	0.80±0.07	25.20±0.58
Ancylostomiasis	0.86±0.09	23.80±1.28
Taeniasis	0.88±0.8	22.80±1.43
Malaria	0.86±0.09	23.8±1.28

Results are expressed as mean ± S.E. (n=5)

*Values are significantly different from control (P<0.05)

Table-5. Serum glucose and Serum Cholesterol level of subjects suffering from parasitic diseases

Group	Serum Glucose (mg/dl)	Serum Cholesterol (mg/dl)
Control	103.80±3.26	183.00±7.33
Ascariasis	105.80±2.58	179.20±7.15
Amoebiasis	103.40±3.31	172.20±5.10
Ancylostomiasis	112.0±3.90	166.40±3.23
Taeniasis	99.0±2.10	157.00±10.59
Malaria	102.60±2.93	176.00±3.56

Results are expressed as mean ± S.E. (n=5)

*Values are significantly different from control (P<0.05)

Hematological study

Group-1. Control:-The haematological study of control group (Group-1) revealed the mean value of haemoglobin, RBC, TLC, Platelets, ESR and PCV to be 14.3 gm/dl, 5.24 million/cumm, 7020/ cumm, 2.26 Lakh/ cumm, 4.2 mm in first hour and 42.2 % respectively. Differential Leucocyte Count revealed the mean value of neutrophils, lymphocytes, eosinophils, monocytes and basophils to be 59.0%, 31.2%, 4.0%, 5.4% and 0.4 % respectively (Table-6 to table-7, Fig-1).

Group-2. Ascariasis:- The haematological study of group-2 revealed the mean value of haemoglobin, RBC, TLC, Platelets, ESR and PCV to be 13.28 gm/dl, 4.66 million/cumm, 6880/ cumm, 1.96 Lakh/ cumm, 4.4 mm in first hour and 39.6 % respectively. Differential Leucocyte Count revealed the mean value of neutrophils, lymphocytes, eosinophils, monocytes and basophils to be 56.8%, 26.0%, 10.6%, 6.0% and 0.6 % respectively. Statistical analysis showed that there was a significant elevation (P<0.05) in eosinophils % in the patients of ascariasis (Table-6 to table-7, Fig-1).

Group-3. Amoebiasis: The haematological study of group-3 revealed the mean value of haemoglobin, RBC, TLC, Platelets, ESR and PCV to be 13.44 gm/dl, 4.8 million/cumm, 7600/ cumm, 2.36 Lakh/ cumm, 5.61 mm in first hour and 38.2 % respectively. Differential Leucocyte Count revealed the mean value of neutrophils, lymphocytes, eosinophils, monocytes and basophils to be 61.6%, 27.2%, 6.6%, 4.6% and 0.2 % respectively (Table-6 to table-7, Fig-1).

Group-4. Ancylostomiasis:-The haematological study of group-4 revealed the mean value of haemoglobin, RBC, TLC, Platelets, ESR and PCV to be 12.94 gm/dl, 4.34 million/cumm, 8120/ cumm, 1.66 Lakh/ cumm, 4.4 mm in first hour and 38.8 % respectively. Differential Leucocyte Count revealed the mean value of neutrophils, lymphocytes, eosinophils, monocytes and basophils to be 58.8 %, 25.8%, 10.2%, 4.6% and 0.6 % respectively. Statistical analysis showed that there was a significant decrease (p<0.05) in level of haemoglobin, RBC, PCV and lymphocytes % and significant elevation (P<0.05) in the eosinophils % in the patients of ancylostomiasis (Table-6 to table-7, Fig-1).

Group-5. Taeniasis:-The haematological study of group-5 revealed the mean value of haemoglobin, RBC, TLC, Platelets, ESR and PCV to be 13.46 gm/dl, 4.7 million/cumm, 7860/ cumm, 2.44 Lakh/ cumm, 5.0 mm in first hour and 39.2 % respectively. Differential Leucocyte Count revealed the mean value of neutrophils, lymphocytes, eosinophils, monocytes and basophils to be 57.4 %, 26.6%, 10.8%, 4.4% and 0.8 % respectively. Statistical analysis showed that there was a significant elevation (P<0.05) in eosinophils % in the patients of taeniasis (Table-6 to table-7, Fig-1).

Group-6. Malaria:- The haematological study of group-6 revealed the mean value of haemoglobin, RBC, TLC, Platelets, ESR and PCV to be 12.86 gm/dl, 4.54 million/cumm, 6080/ cumm, 1.35 Lakh/ cumm, 5.8 mm in first hour and 39.0 % respectively. Differential Leucocyte Count revealed the mean value of neutrophils, lymphocytes, eosinophils, monocytes and basophils to be 61.0 %, 31.0%, 3.0%, 4.4% and 0.6 % respectively. Statistical analysis showed that there was a significant decrease (P<0.05) in level of haemoglobin, RBC, TLC, Platelets and PCV (Table-6 to table-7, Fig-1).

Table-6. Haemoglobin, RBC, TLC, Platelets counts, ESR and PCV of subjects suffering from parasitic diseases.

Group	Hb (Gm/dl)	RBC Counts (Million/cu mm)	TLC (/cumm)	Platelets (Lac/cumm)	ESR (mm in 1st hour)	PCV (%)
Control	14.38±0.29	5.24±0.05	7020±255.73	2.26±0.22	4.2±0.37	42.2±0.86
Ascariasis	13.28±0.41	4.66±0.30	6880±270.92	1.96±0.23	4.40±0.51	39.60±1.25
Amoebiasis	13.44±0.42	4.8±0.19	7600±391.15	2.36±0.23	5.61±0.81	38.8±2.48
Ancylostomiasis	*12.94±0.43[1]	*4.34±0.34[3]	8120±550.82	1.66±0.19	4.4±0.51	*33.80±2.18[7]
Taeniasis	13.46±0.29	4.7±0.23	7860±557.31	2.44±0.29	5.0±1.26	39.20±1.24
Malaria	*12.86±0.45[2]	*4.54±0.25[4]	*6080±243.72[5]	*1.35±0.07[6]	5.8±1.11	*39.0±0.89[8]

Results are expressed as mean ± S.E. (n=5)

*Values are significantly different from control (P<0.05P

[1]P=0.0231, t= 2.8026, d.f. =8, [2]P=0.0211, t= 2.8623, d.f. =8 [3]P=0.0313, t= 2.6068, d.f. =8

[4]P=0.0254, t= 2.7414, d.f. =8 [5]P=0.0288, t= 2.6609, d.f. =8 [6]P=0.0089, t= 3.5855, d.f. =8

[7]P=0.0071, t= 3.5883, d.f. =8 [8]P=0.0327, t= 2.5786, d.f. =8

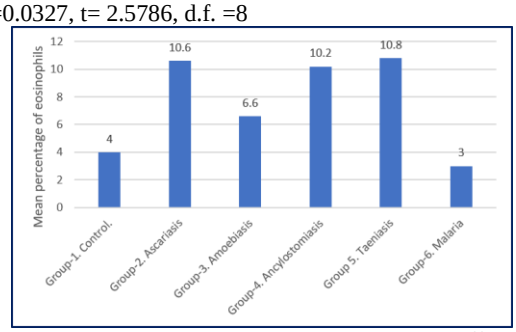

Fig-1. Figure showing significant alteration in mean eosinophils percentage in different group of parasitic diseases.

Table-7. Differential Leucocyte Count (DLC) of subjects suffering from parasitic diseases.

Group	Polymorphs (%)	Lymphocytes (%)	Eosinophils (%)	Monocytes (%)	Basophils (%)
Control	59.00±2.28	31.20±1.88	4±0.71	5.40±0.51	0.4±0.24
Ascariasis	56.80±1.59	26.00±1.41	*10.60±1.08[2]	6±0.71	0.6±0.24
Amoebiasis	61.60±1.54	27.20±1.46	*6.60±0.51[3]	4.60±0.75	0.20±0.20
Ancylostomiasis	58.80±0.86	*25.80±0.86[1]	*10.20±0.49[4]	4.60±0.40	0.60±0.24
Taeniasis	57.40±0.93	26.60±0.98	*10.80±0.58[5]	4.4±0.51	0.80±0.20
Malaria	61.00±2.05	31.00±2.0	3±0.45	4.4±0.51	0.60±0.24

Results are expressed as mean ± S.E. (n=5)

*Values are significantly different from control (P<0.05P

[1]P=0.0311, t= 2.6102, d.f. =8, [2]P=0.0009, t= 5.1226, d.f. =8 [3]P=0.0175, t= 2.9824, d.f. =8

[4]P=0.0001, t= 7.2074, d.f. =8 [5]P=0.0001, t= 7.4194, d.f. =8

Discussion

Statistical analysis showed that there was a significant decrease (P<0.05) in serum protein and albumin levels in the patients of ancylostomiasis. Kendre *et al*. 2019 and Saraya *et al*. 1970 also observed the decreased level of serum protein and albumin levels in the patients of ancylostomiasis. Present author is of opinion that hypoalbuminemia develops when blood loss exceeds iron and protein intake and stores. However present study did not reveal alteration in the serum protein and albumin levels in the patients of ascariasis, amoebiasis and taeniasis. However, several authors reported elevation in the level of serum alkaline phosphatase, SGOT and SGPT in the patients of amoebiasis (Braunwald *et al*. 2001, Chatterjee, 2019). This is contrary to the present study; this in part may be related to the fact that E. histolytica does not normally involve the liver but chronic infection can alter levels of total bilirubin, direct bilirubin, SGPT, and SGOT. Statistical analysis of malaria cases showed that there was a significant decrease (P<0.05) in serum albumin levels and significant elevation (P<0.05) in the level of serum ALP, total bilirubin, direct bilirubin, indirect bilirubin, SGPT and SGOT in the patients of malaria parasite. Similar to this Akor *et al*. (2021) reported the statistically significant elevation in the level of serum ALP, SGPT and SGOT in the patients of malaria. Further another biochemical study was carried out on co-infection of malaria and Schistosoma mansoni which

showed increased levels of serum ALP, SGPT, SGOT, total bilirubin, direct bilirubin and decreased levels of total protein (Abede *et al*. 2024). All these studies are supporting the present study. Here our opinion is that, all these studies along with our results are proving that malaria parasite not only induces inflammation of hepatocytes but also increases their workload due to which ALP, SGPT, SGOT, total bilirubin and direct bilirubin increase in the blood. Several studies have been shown elevated levels of lipoproteins like high density lipoprotein (HDL), low density lipoprotein (LDL) and total cholesterol in patients suffering from parasitic infection (Faucher *et al*. 2002, Bansal *et al*. 2005). This is contrary to the present study in which no significant alteration in serum cholesterol levels were observed. Present authors are of opinion that, cholesterol may have different values in different stages of infection. Therefore, cholesterol level may be different at different stages. Further research is needed to make this point clearer.

Statistical analysis showed that there was a significant elevation ($P<0.05$) in eosinophils percentage in the patients of ascariasis, ancylostomiasis, taeniasis. Similarly, another study also reported that parasitic diseases often induce eosinophilia (Newton *et al*. 2013). In a different study, observed that the parasites found to be responsible for eosinophilia were Trichuris trichiura, Ascaris lumbricoides, Strongyloides stercoralis, filarial worm and hook worm (Khanna *et al*. 2015). In a case study of neurocysticercosis 10% eosinophilia was reported (Bauer *et al*. 1994). These findings support the observations of present authors. Haematological study of patients of ancylostomiasis showed the significant decrease ($P<0.05$) in level of haemoglobin, RBC, and PCV. Similar findings also reported in a prospective cohort study (Demeke *et al*. 2021). Haematological study of malaria patients showed the significant decrease ($P<0.05$) in level of haemoglobin, RBC, TLC, Platelets and PCV. Like this, in a systematic review total leucocyte count was significantly lower in patients with malaria (Kotepui *et al*. 2020). In another study of malaria revealed the significant decreased in value of WBC, platelets, RBC, PCV and haemoglobin in malaria infected cord blood in comparison to malaria negative persons (Akor *et al*. 2021). These studies support the findings of present study. Present authors are of opinion that the RBC breakdown due to malaria parasite infection is responsible for the decreased level of RBC, PCV and haemoglobin in malaria infected patients. The present authors also state that decreased TLC and platelet counts in malaria patients may be due to increased platelet consumption, destruction, aggregation, as well as possible bone marrow suppression.

Conclusion

This study shows that parasitic infection alters biochemical and haematological parameters. Therefore, biochemical and haematological parameters should be used to monitor and manage complications related to parasitic infection. At the same time, educating the population, promoting good hygiene practices and using deworming services as needed will be helpful in preventing the spread of malaria and intestinal parasitic infections.

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