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THE PATTERN OF PACKED CELL VOLUME, PLASMA ELECTROLYTES AND GLUCOSE LEVELS IN PATIENTS INFECTED WITH *PLASMODIUM FALCIPARUM*

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Fifty-two patients (27 males, 25 females aged 25 ± 18.4 years) with *Plasmodium falciparum* infection and 53 healthy control subjects (27 males, 26 females aged 28.3 ± 19.2 years) were recruited for the study. Plasma electrolytes (Na^+ , K^+ , Cl^-), glucose and HCO_3^- were respectively analyzed colorimetrically and biochemically. There was an observed lower significant mean value of packed cell volume, Na^+ , HCO_3^- and glucose in *Plasmodium falciparum* infected subjects than the values obtained from the normal control subjects with $P < 0.05$. Higher significant mean value of Cl^- and K^+ was observed in the test than the control subjects ($P < 0.05$). Significantly lower packed cell volume, Na^+ , Cl^- , glucose and higher significant K^+ levels were observed in the test subjects aged 1-10 years than test subjects aged 11-72 years with $P < 0.05$. This study further affirms the effects of *Plasmodium falciparum* infection on the pattern of packed cell volume, plasma electrolytes and glucose concentrations.

Keywords: Electrolytes, *Plasmodium falciparum*, Glucose, Packed Cell Volume

INTRODUCTION

Plasmodium falciparum is a mosquito-borne haemoparasite causing falciparum, malignant tertian or subtertian malaria (1-3). The parasite invade all ages (old and young) of erythrocytes indiscriminately so that very high infection rates may occur and anaemia is most pronounced in falciparum infections with extensive and rapid destruction of red blood cell (1, 3). Haemolysis in malaria infection may be due to antigen-antibody plus complement reaction and excessive destruction of erythrocytes by the invading parasite (1). Haemolysis may also arise from autoimmune response or opsonization of the infected erythrocytes in *Plasmodium falciparum* (1).

Loss of potassium (the major intracellular fluid cation) from red cells to the extracellular fluid will raise the plasma level of potassium and promote extracellular acidosis (4). Low urinary concentration of chloride in the infected

subjects have also been reported (1). This study was designed to measure the effect of *Plasmodium falciparum* infection on the pattern of packed cell volume (PCV) and the electrolytes (Na^+ , K^+ , Cl^- and HCO_3^-) in the extracellular fluid (plasma) of the infected subjects.

MATERIALS AND METHOD

Subjects/Study area

Fifty-two patients (27 males, 25 females aged 25 ± 18.4 years) with *Plasmodium falciparum* infection and 53 healthy control subjects (27 males, 26 females aged 28.3 ± 19.2 years) were recruited from the Medial Outpatient Department of Baptist Medical Center, Saki, Oyo State, Nigeria, for the study.

Sample collection/Materials

Six to 10 milliliters of venous blood was collected from each subject and divided into 2 parts. One part was collected into Lithium heparinized tubes and used for blood film examination for malarial parasite and analysis of plasma electrolytes. The other part was preserved

in Fluoride-Oxalate anticoagulated bottles for the analysis of glucose.

Method

Thin and thick blood film Field's stain technique described by Cheesbrough (5) was used to identify *Plasmodium falciparum* in the blood film.

Plasma was extracted from the blood by centrifugation at 1500 rpm for 5 minutes. Plasma potassium was estimated by colorimetric method of Terri *et al* (6). Plasma sodium was estimated by colorimetric method of Maruna (7) and Trinder (8) using the kit of Teco Diagnostics (4925E, Hunter Ave, Anachem, CA 92807). Plasma chloride was analyzed by the colorimetric mercuric thiocyanate - iron III nitrate method using the kit of Quimica Clinica Applicada (SA, Amposta, Spain). Plasma bicarbonate was analyzed by the method described by Van Slyke (9).

Packed cell volume was determined by capillary tube method described by Cheesbrough (10) and plasma glucose was estimated by colorimetric glucose oxidase method of Trinder (11).

RESULT

The observed mean values of this study are as shown in Tables 1-3. The mean values of the PCV ($28.1 \pm 10.0\%$), Na^+ (137.7 ± 5.5 mmol/L), HCO_3^- (27.9 ± 4.7 mmol/L) and glucose (86.8 ± 6.0 mg/dL) observed in the *Plasmodium falciparum* infected subjects were significantly lower than the mean values obtained from the control/normal subjects of $34.8 \pm 5.2\%$, 140.5 ± 4.7 mmol/L, 29.8 ± 1.2 mmol/L and 92 ± 8.3 mg/dL, respectively ($p < 0.05$).

A higher significant mean value of K^+ (5.5 ± 0.83 mmol/L) and Cl^- (109.3 ± 6.0 mmol/L) were observed in the *Plasmodium falciparum* infected subjects than the mean values of K^+ (4.1 ± 0.38

mmol/L) and Cl^- (99.0 ± 1.43 mmol/L) observed in the normal control with $p < 0.05$ (Tables 1 and 2).

Considering Tables 1 and 3, there was an observed lower significant mean values of PCV ($15.5 \pm 4.9\%$), Na^+ (133.5 ± 6.0 mmol/L), Cl^- (105.1 ± 6.5 mmol/L) and glucose (81.33 ± 3.4 mg/dL) in *Plasmodium* infected subjects aged 1-10 years compared with the mean values of PCV ($33.3 \pm 6.4\%$) and glucose (89.1 ± 5.3 mg/dL) obtained from the *Plasmodium* infected subjects aged 11-72 years with $p < 0.05$. A higher significant mean value of potassium (K^+) was observed in the *Plasmodium falciparum* infected subjects aged 1-10 years than infected subjects aged 11-72 years (6.4 ± 0.49 mmol/L versus 5.2 ± 0.7 mmol/L) with $p < 0.05$.

There was no statistical significant difference in the mean values of HCO_3^- in *Plasmodium falciparum* infected subjects aged 1-10 years compared with the infected subjects aged 11-72 years with $p > 0.05$ ($\text{HCO}_3^- = 28.1 \pm 4.9$ versus 30.2 ± 3.4 mmol/L).

Table 1: The mean \pm standard deviation of PCV, plasma levels of electrolytes and glucose in *Plasmodium falciparum* infected patients and normal subjects.

		PCV	K ⁺	Na ⁺	HCO ₃ ⁻	Cl ⁻	Glucose
Test subjects (n = 52)	X \pm SD	28 \pm 10.0	5.5 \pm 0.83	137.7 \pm 5.5	27.9 \pm 4.7	109.3 \pm 6.0	86.8 \pm 6.0
Control-subjects(n=53)	X \pm SD	34.8 \pm 5.2	4.1 \pm 0.38	140.5 \pm 4.7	29.8 \pm 1.2	99.0 \pm 1.4	92.0 \pm 8.3
<i>P. falciparum</i> infected 1-10 years (n = 15)	X \pm SD	15.5 \pm 4.9	6.4 \pm 0.49	133.5 \pm 6.0	28.1 \pm 4.9	105.1 \pm 6.5	81.3 \pm 3.4
<i>P. falciparum</i> infected 11-72 years (n = 37)	X \pm SD	33.3 \pm 6.4	5.2 \pm 0.7	139.4 \pm 4.3	30.2 \pm 3.4	111.5 \pm 4.1	89.1 \pm 5.3

Table 2: The values observed in the test subjects versus control

	PCV	K ⁺	Na ⁺	HCO ₃ ⁻	Cl ⁻	Glucose
"T" value	4.1	10.8	2.8	4.0	12.1	2.6
"P" value	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

Table 3: The observed values in test subjects aged 1-10 years versus the mean values for those aged 11-72 years

	PCV	K ⁺	Na ⁺	HCO ₃ ⁻	Cl ⁻	Glucose
"T" value	6.6	7.0	3.4	1.52	3.5	6.3
"P" value	< 0.05	< 0.05	< 0.05	> 0.05	< 0.05	< 0.05

DISCUSSION

The observed significantly lower packed cell volume (PCV) and higher potassium (K⁺) in the *Plasmodium falciparum* infected subjects than the normal subjects can be attributed to the massive destruction of the infected erythrocytes by the organism. This will in effect lower the PCV and increase the level of K⁺ in the plasma as a result of the influx of this major intracellular cation from the intracellular to the extracellular fluid (1, 3, 4, 5, 12).

Significantly lower Na⁺, HCO₃⁻ and higher Cl⁻ levels in the test subjects than the normal control are attributable to the fact that high level of K⁺ can directly stimulate the release of aldosterone from adrenal gland and also increases the delivery of HCO₃⁻ to the cortical collecting duct by inhibiting HCO₃⁻ reabsorption in

the proximal tube thereby lowering the HCO₃⁻ / Na⁺ level (13).

The lower significant mean sodium level obtained from the test subjects than the control can also be attributed to vomiting and haemolysis which causes raised plasma potassium level thereby forcing more Na⁺ back to the cell to maintain electrochemical neutrality (2). The observed higher chloride level in the test than the control can also be attributed to the fact that the urinary concentration of chloride is always low in *Plasmodium falciparum* infection, which may be due to Cl⁻ retention (1).

Glucose level observed in the *Plasmodium* infected subjects, which was lower than the normal control, is consistent with the reports of Maruna (7) and Warrell *et al* (12), in which low

glucose level is associated with the infected subjects.

The observations in this study in the subjects' aged 1-10years considering the lower significant packed cell volume and glucose, and higher potassium level compared to the test subjects aged 11-72years, agrees with the reports of Terri and Sesin (6), Maruna (7), and Warrell *et al* (12) that the disease is more severe in children, who usually present with anaemia and hypoglycaemia.

This study in essence has affirmed the observations of previous workers of the effects of *Plasmodium falciparum* infection on the packed cell volume, plasma electrolytes and glucose, in patients seen in this locality.

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