Study to evaluate serum sodium, potassium and chloride level in malaria and its association with severity of malaria

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Abstract

Introduction: Malaria is life threatening protozoal infection caused by plasmodium species and it is major health problem in India. Electrolyte alternation is commonly occurring in infections like malaria due to effects of parasitaemia on host cells. The objectives of study were to assess serum level of sodium, potassium and chloride in malaria cases and to find association of electrolyte alteration with severity of malaria infection in different type of malaria.

Materials and Methods: Total 70 cases of P. falciparum, 70 cases of P. vivax and 70 age matched healthy controls were included in the study. Diagnosis of malaria was confirmed by QBC (Quantified buffy coat) malaria test. Estimation of electrolyte was done by direct ISE method.

Result: There were significantly decreased in mean sodium, potassium and chloride level in P. falciparum malaria cases compare to controls (P< 0.01). There were significantly decreased in mean sodium and chloride level in P. vivax cases compared to controls (P< 0.01). Hyponatremia was significantly associated with severity of infection (P< 0.001). Hypokalemia was significantly associated with severity of infection in P. falciparum malaria (P< 0.05).

Conclusion: Hyponatraemia, hypokalaemia and hypochloremia are found in malaria particularly in P. falciparum type. Hyponatremia and hypokalemia are associated with severity of malaria infection.

Keywords: Hyponatraemia, Hypokalaemia, Hypochloremia, Malaria, Serum electrolytes.

Introduction

Malaria is life threatening protozoal infection caused by plasmodium species and transmitted by anopheles mosquitoes. It is most prevalent in tropical country like India.[1] According to latest world malaria report 2017, around 1-1.8 million cases have been reported and death occurs in around 20-45 thousand cases in year 2016.[2] It continuous to be lethal infection, because of resistance of anti-malarial drugs in plasmodium, resistance of insecticides in vectors, migration and travelling of cases. Malaria infections caused by various plasmodium species like P.falciparum, P.vivax, P.ovale and P.malariae.[3] Complications like renal failure, cerebral malaria, electrolyte imbalance were found more in P.falciparum malarial infections.[4]

Serum electrolyte like Na^+, K^+ and Cl^- play crucial role in maintaining homeostasis, fluid balance and acid base balance. Hospitalization in cases of malaria is required due to complications of high fever such as nausea, vomiting and headache. Fluid and electrolyte imbalance is more common amongst these patients.[5] Disturbances in Na+, K+, and Cl- level have been reported in P. falciparum malaria[6] but results were conflicting. We hypotheses that electrolyte imbalance may be associated with type and severity of malaria.

Biological reference range for serum Na^+ in adult is 136-145 mmol/L.[7] Hyponatremia is defined as decreased serum Na+ level < 135mmol/L. It further classified in to mild, (131-135mmol/L) moderate (126-130) and severe (<126mmol/L) type of hyponatremia.[7] Hypernatremia is defined as increase serum Na+ level > 150mmol/L.[7]

Biological reference range for serum K+ in adult is 3.5 to 5.1mmol/L.[7] Hypokalemia is defined as decreased serum K+ level < 3.5mmol/L. If further classified in to mild (3.0-3.5mmol/L), moderate (2.5-3.0mmol/L) and severe (< 2.5mmol/L) type of hypokalemia.[7] Hyperkalemia is defined as increase K+ level > 5.0 mmol/L. Biological reference range for serum chloride in adult is 98.0-107.0 mmol/L. Change in serum chloride level has a less clinical importance.[7]

Based on above knowledge, we carried out a study to evaluate serum level of Na+, K+, Cl- in P. falciparum and P. vivax infections and to find association of electrolyte imbalance with severity of malaria infections.

Materials and Methods

The prospective study was carried out in clinical biochemistry laboratory and department of Medicine at KMC hospital, Mangalore. Patients admitted in medicine ward with symptoms of fever with chills, vomiting, headache, weakness, irritability, loss of appetite were the target subjects of the study. Total 70 cases of P. falciparum, 70 cases of P. vivax and 70 age and sex matched healthy controls were included in this pilot study. Detailed present & past history of any chronic disease and physical examination was carried out in all cases. Diagnosis of malaria was confirmed by

QBC (Quantified buffy coat) malaria test. QBC test contain anticoagulant coated tube and acridine orange dye was used to examine malaria parasite under fluoresce microscopy. Written informed consent was taken from all participants and research study was approved by local ethical committee of KMC Hospital, Mangalore.

Selected cases were further divided in to uncomplicated malaria and severe malaria. Severe malaria cases were selected according to WHO revised criteria.[8] Components of WHO revised criteria were parasitaemia (>5% of RBC), coma, convulsion, anaemia (Haemoglobin less than 8 gm/dL), renal impairment (creatinine >2.5 mg/dL or urine output < 400ml/24 hours), respiratory failure, hypoglycaemia (blood glucose <40 mg/dL), AST/ALT >3 x UNL, icterus (bilirubin >3 mg/dL), spontaneous bleeding (platelet counts < 20000/ul), circulatory collapse (blood pressure less than 80/50 mmHg), acidosis (pH <7.25). If any one of the above criteria was present then it was considered as severe malaria.[8]

Inclusion Criteria: 140 newly diagnosed malaria patients above 18 years of age were included as cases. 70 age and sex matched controls were included in the study.

Exclusion Criteria: Known cases of diabetes ketoacidosis, renal failure, asthma/COPD, heart failure, liver failure were excluded as it may cause electrolyte imbalance.

Sample Collections: Under aseptic conditions with all the precautions, 8 ml of venous blood collected from all the study subjects in plain vial and EDTA vial. EDTA tube was used for complete blood count estimation and QBC malaria test. Blood samples of plain vial were centrifuged at 2000 rpm for 20 minutes to separate serum. Serum was immediately used to investigate N^+, K^+, and Cl^-. Estimation of electrolyte was done by direct ISE method on Roche hitachi 911 chemistry analyser.

Statistical Analysis

The data from the study was analyzed by using Statistical Package for Social Sciences 16. The results are presented as Mean ± SD and compared by Student's t-test. Association of electrolyte imbalance with severity of malaria was done by chi-square test. P value < 0.05 was considered as a significant.

Results

We were found study population age of 18-65 years. There is no difference of change in electrolyte among male and female. Table 1 is showing comparison the electrolyte disturbance between P. falciparum cases and controls group. There was significant electrolyte disturbance of sodium, potassium and chloride between P. falciparum cases and controls (P < 0.01). Serum level of sodium, potassium and chloride were decreased in P. falciparum cases compared to controls group.

Table 1: Mean ccomparison of serum electrolytes between P.falciparum cases and controls group

Serum electrolytes mmol/L	P. falciparum Cases (n=70) Mean±SD	Controls (n=70) Mean±SD	P value
Sodium (Na+)	126.8 ± 3.46	139.06 ±2.25	< 0.01*
Potassium (K+)	3.01 ± 0.52	4.52 ±0.40	< 0.01*
Chloride (Cl-)	94.5 ±3.50	101.13 ±3.47	< 0.01*

*****Student t-test

Table 2 is showing comparison the electrolyte disturbance between P. vivax cases and controls group. There was significant electrolyte disturbance of sodium and chloride between P. viax cases and controls (P < 0.01). Serum level of sodium and chloride were decreased in P. vivax cases compared to control groups. There was no significant difference of potassium between P. vivax cases and controls group (P > 0.27).

Table 2: Mean ccomparison of serum electrolytes between P. vivax cases and controls group

Serum electrolytes mmol/L	P.vivax Cases (n=70) Mean±SD	Controls (n=70) Mean±SD	P value
Sodium (Na+)	131.7 ± 2.25	139.06 ± 2.25	< 0.01*
Potassium (K+)	4.28 ±0.39	4.5 ±0.40	0.27
Chloride (Cl-)	98.47 ± 3.54	101.13 ±3.47	< 0.01*

*****Student t-test

After comparison of electrolyte disturbances among cases and controls, we have investigated the association between hyponatremia and hypokalemia with severity of P. falciparum malaria and hyponatremia with severity of P. vivax infection. Table 3 is showing significant association of hyponatremia with the severity of P. falciparum and P. vivax malaria

(P value <0.001). Table 4 is showing significant association hypokalemia with P. falciparum malaria (P value <0.05).

Table 3: Association of hyponatremia with uncomplicated and severe cases of P.falciparum and P.vivax malaria

Serum Na+ level	Uncomplicated cases (n=73)	Severe cases (n=67)	P value
< 126.0mmol/L	10	32	<0.001*
126.0-130.0mmol/L	28	20	<0.001*
>131.0 mmol/L	35	15	<0.001*

*Chi-square test

Table 4: Association of hypokalemia with uncomplicated and severe cases of P. falciparum malaria

Serum K+ level	Uncomplicated cases (n=37)	Severe cases (n=33)	P value
< 2.5mmol/L	5	16	<0.05*
2.5-3.0mmol/L	12	10	<0.05*
>3.0 mmol/L	20	7	<0.05*

*Chi-square test

Fig. 1-3 are showing comparison of electrolyte disturbances among cases and controls

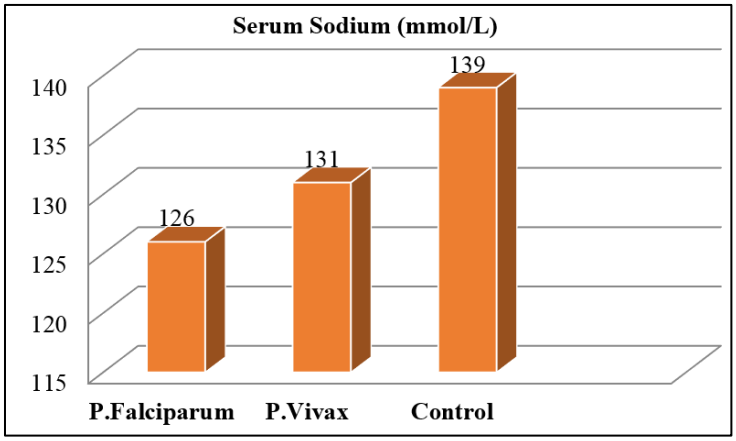

Fig. 1: Comparison of alternation in sodium level in cases and controls

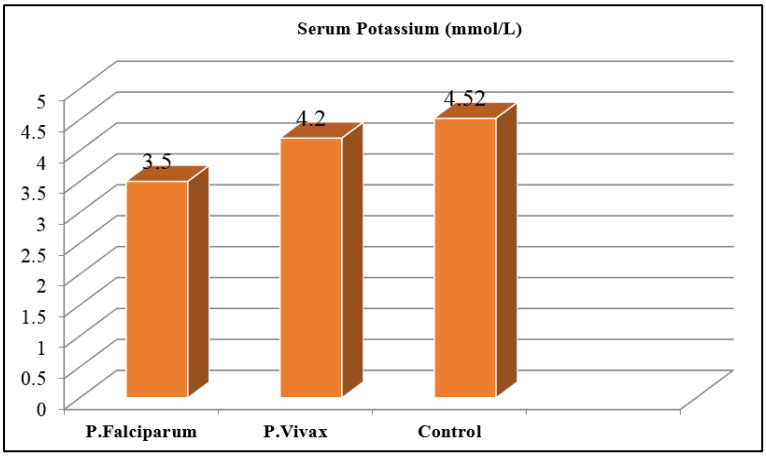

Fig. 2: Comparison of alteration in potassium level in cases and control

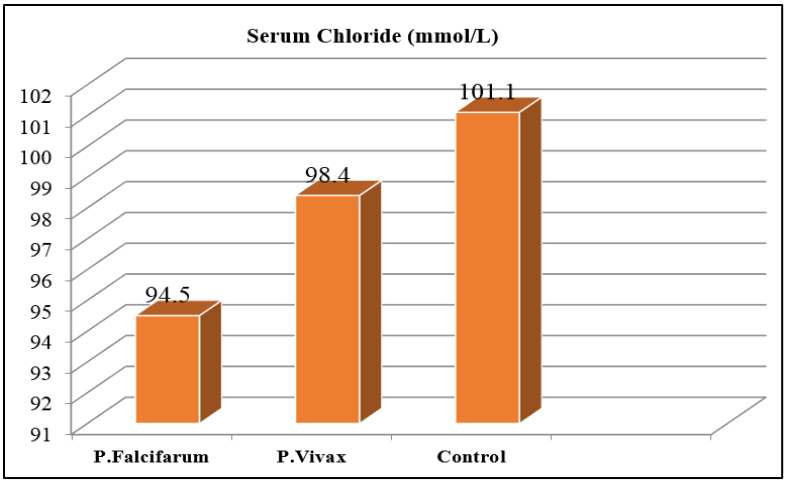

Fig. 3: Comparison of alteration in chloride level in cases and controls

Discussion

Malaria is major health problems causes morbidity and mortality in India. Improper treatment and management causes serious complications like brain & kidney damage and death of the patients.[9] We found hyponatremia, hypochloremia in P. falciparum and P. Viavxmalaria cases and hypokalemia in P. falciparum malaria cases. Hyponatremia is associated with severity in both P.falcipaurm and P. vivax. Hypokalemia is associated with severity of malaria only in P. falciparum malaria. We did not compare Cl- with severity as hypochloremia has little clinical significance.

We were found hyponatremia in both P. falciparum and P. vivax. Exact cause of hyponatremia in malaria is not known. We hypotheses that it may be due to dehydration, vomiting, renal failure.[10] Hyponatremia could be due to increased secretion of anti diuretic hormone in response to hypovolaemia in severe malaria infection.[11] There is also significant association between severity of hyponatremia with the severity of malaria. It suggests more decrease in Na+ level in severe malaria compared to uncomplicated malaria. Severe hyponatremia suggests severity of malaria infections. Similarly, hyponatremia was also found in study reported by Jasmin H. et al (2012),[12] Asima Rani. et al (2012).[13]

We were found hypokalemia in P. falciparum cases only. It was also associated with severity of the P. falciparum infections. During attack of P. falciparum malaria, host cell losses majority of potassium ion from the cell as P. falciparum resides inside the cells and it may be a reason for hypokalemia.[14] Increased excretion of the potassium ion from the kidney and excess vomiting in P. falciparum malaria infection may also cause hypokalemia. Severe hypokalemia suggest severity of P. falciparum malaria infection. Similarly, hypokalemia was also found in study reported by Yoel C (2007).[15] We were also found hypochloremia in P. falciparum and P. viax malaria as it occurs simultaneously with hyponatremia. Similarly, hypochloremia was reported in malaria infections by Baloch S (2011).[16]

Serum electrolytes should be analyzed in all malaria cases to prevent critical complication. If severe decrease in sodium occurs then special attention should be given in treatment to as indicate severity of malaria infections.

Limitations

Study should be done on large population and also outdoor patients should be included to validate the results of study.

Conclusion

Hyponatremia, hypokalemia and hypochloremia are associated with P. falciparum malaria. Hyponatremia and hypochloremia are associated with P. viax infection. Hyponatremia suggest severity of infection in both P. falciparum and P. vivax while hypokalemia suggest severity of infection only in P. falcipaum cases. It is crucial to estimate serum sodium, potassium and chloride at early stage to avoid serious consequences.

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