EUROPEAN ACADEMIC RESEARCH
Vol. VII, Issue 8/ November 2019

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Evaluation of Plasma Electrolytes (Sodium and Potassium Levels) among Sickle Cell Anemia Patients Attended to Kosti and Rabak Teaching Hospitals, Sudan

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Abstract

Sickle cell anemia is a type of Hemoglobin disorder associated with biochemical abnormalities such as imbalance of electrolytes. This study was aimed to evaluate plasma sodium and potassium levels among sickle cell anemia patients attended to Kosti and Rabak teaching hospitals in Sudan during the period from August to October 2017. This is a case control study was done in seventy five sickle cell anemia patients and fifty healthy controls. About 3ml of venous blood were collected using sterile syringes and poured into lithium heparin *containers then centrifuged to obtained plasma which use to measure sodium and potassium levels using Ion selective electrode. This study showed that the levels of sodium and potassium were significantly less in case group (adult and children) when compared with healthy controls group (134 ± 7mmol/L, 140±3mmol/L for sodium in case and control group respectively . while 3.7±0.6 mmol/l, 4.3±0.57 mmol/l for potassium in case and control group respectively). This study has explained that sodium and potassium levels have a role in sickle cell anemia which could be used in designing of the better management of sickle cell anemia patients.*

Keywords: Haemoglobinopathy, Sickle cell anemia, Electrolytes, polymerization, hemoglobin S.

1.INTRODUCTION:

Sickle cell anemia, a type of Haemoglobinopathy is a group of hemoglobin disorders that occurs because of mutation in beta globulin gene of hemoglobin molecule, that leads to formation of abnormal hemoglobin designated as hemoglobin S (HbS) (1).

Sickle cell disease (SCD) is an inherited disorder in which there is a point mutation arising from the substitution of glutamic acid by valine at the sixth position on the beta polypeptide chain (2). This point mutation is responsible for alteration in the properties of the hemoglobin tetramer, with a tendency to polymerize in the deoxygenated state (3), altering normal, flexible biconcave shaped red blood cells (RBCs) into stiff, rigid, sickle cell. The rate of polymerization of Sickle cell hemoglobin (HbS) is directly related to fundamental pathophysiology of hemolytic anemia and vaso-occlusion (4). The sickle shaped red blood cells cannot carry as much oxygen as normal shaped cells to the tissues and they become stuck in the blood vessels, blocking blood flow to the organs. SCD is one of the most commonly observed Haemoglobinopathies affecting millions of people in the world and poses a significant challenge for clinicians and scientists (5).It is estimated that there are between 70,000 to 100,000 people in the United States that are affected with SCA, and one in 500

African-American newborns is diagnosed with the disorder every year (6).The highest prevalence of SCD in Sudanese is among the population from the Western Sudan , it is believed that the sickle cell gene has brought to Sudan through immigrants from West African tribes, especially from Hausa and Bargo (7,8). Sickle cell anemia (SCA) is accompanied with various clinical manifestations such as jaundice, cutaneous ulcer, skeletal changes and episodes of intravascular sickling and thrombosis resulting in painful crisis and infarcts in various organs (9). Sickle cell pain crises are precipitated by infection, dehydration and hypoxia. Intercurrent infections particularly of respiratory tract, fever, abdominal, skeletal pain, and bone pain crisis are the main causes of morbidity in sickle cell patients (10).There are excellent treatments for the symptoms and complications of the condition, but in most cases there is no cure (11).

Electrolytes are substances that become ions in solution and acquire the capacity to conduct electricity. Electrolytes measured by blood testing includes sodium (Na), potassium (K),chloride (Cl),calcium (Ca) and bicarbonate (HCO_3) (12). Any significant change in the electrolyte levels leads to serious complications. Thus, a proper functioning of body requires a proper balance between these electrolytes (12, 13). Sodium forms one of the major positive ion commonly found in the fluid present outside of the cells(1). Its main function being regulation of the amount of total body water along with its critical role in electrical communication especially in the brain, nervous systems and muscles. Potassium is the major positive ion that is commonly found in the interior of the cells. The proper level of potassium is necessary for normal cell function. Among the many functions of potassium in the body are regulation of the heart beat and function of the muscles (14).Biochemical abnormalities related to imbalance of electrolytes have been associated with sickle cell anemia. Various studies involving sickle cell patients have shown that there are increased and continued obligatory losses of body fluids and electrolytes resulting in dehydration and other metabolic disturbances (12). It has been demonstrated that sickling is accompanied by an intra erythrocytic loss of potassium and gain of sodium, thus creating disequilibrium in the ionic strength across the cell membrane(15).

2. METHODOLOGY (MATERIALS AND METHODS)

2.1 Study design:

This is case-control study, carried out in Rabak and Kosti teaching hospitals White Nile state in Sudan during the period from August to October 2017.

2.2 Sample size:

The sample size was 75 patients with Sickle cell anemia and 50 age and sex matched healthy controls.

2.3 Study criteria :

2.3.1 Inclusion criteria:

patients already diagnosed with sickle cell anemia .

2.3.2 Exclusion criteria:

- patients with Autoimmune diseases.
- patients with other systemic diseases.

2.4 Ethical Consideration:

This study was approved by ministry of health (White Nile state) and ethical committee board of University of EL Imam EL Mahdi . All participants were completed an individual informed consent form.

2.5 Data collection:

Data was collected by the direct interview and questionnaire.

2.6 Statistical analysis:

All data were analyzed using statistical package for social sciences (SPSS) software version 21. Mean and standard deviation of sodium and potassium was calculated.

2.7 Sample collection:

In all subjects under all aseptic precautions 3ml of venous blood was collected using sterile disposable syringes and poured into heparin bottle. The plasma was separated by centrifuged the whole blood at 3000 rpm for 5 minutes.

2.8 Biochemical Analysis :

Measurement of Sodium and Potassium levels using Ion selective electrode (E-lyte plus Electrolytes analyzer).

❖**Principle of Ion selective electrode :**

Ion selective electrode is a kind of electrochemical sensor (also called an electrode). The activity changes of a specific ion can be converted into the electrical potential changes of the electrode. The numerical values of the concentration gradient relate to the electric gradient that balance it, according to the Nernst equation.

Nernst equation:

$$E = E_0 + \frac{2.3026RT}{ZF} \log_{10} a(x)$$

❖**Clinical Electrolytes Range:**

- Sodium (136 – 145 mmol/L)
- Potassium (3.5 – 5.2 mmol/L)

3. RESULTS

Sample size of this study was 75 patients with sickle cell anemia and 50 age and sex matched healthy controls. Among 75 case group 46 were males (61%) (32 children and 14 adults) and 29 were females(39%) (18 children and 11 adults) while healthy controls group was composed of 30 males (60%) (18 children and12 adults) and 20 female (40%) (8 children and 12 adults) as shown in **(Tables 1,2,3,4)**. The mean and standard deviation (mean ± SD) of ages of the case group (children) were 9 ± 4.5 years and (adults) were 24.6 ± 5 years as shown in **(Table 5)** ,while the mean and SD of ages of the control group (children) were 8.6 ± 4.3 years and (adults) were 24.6 ± 4.5 years as shown in **(Table6)**.

The mean and SD of sodium level in case group (children) were 134± 7 mmol/L while potassium level were 3.6± 0.6 mmol/L as shown in **(Table7)**.

The mean and SD of sodium level in control group (children) were 140 ± 3 mmol/L while potassium level were 4.2± 0.5 mmol/L as shown in **(Table 8)**.

The mean and SD of sodium level in case group (adults) were 135± 7 mmol/L while potassium level were 3.9 ± 0.6 mmol/L as shown in**(Table 9)**.

The mean and SD of sodium level in control group (adults) were 140± 3 mmol/L while Potassium level were 4.5± 0.6 mmol/L as shown in **(Table10)**.

The mean and SD of sodium level in case group (adults and children) were 134± 7 mmol/L while potassium level were 3.7 ± 0.6 mmol/L as shown in **(Table 11)**.

The mean and SD of sodium level in control group (adults and children) were 140±3 mmol/L while Potassium level were 4.3± 0.5 mmol/L as shown in **(Table12)**.

Table (3.1): Shows the frequency of sex in case group (children):

Sex	**Frequency**	**Percent**
Male	32	***64***%
Female	18	***36***%
Total	50	***100***%

Table (3.2): Shows the frequency of sex in control group (children):

Sex	Frequency	Percent
Male	12	60%
Female	8	40%
Total	20	100%

Table (3.3): Shows the frequency of sex in case group (adults):

Sex	**Frequency**	**Percent**
Male	14	56%
Female	11	44%
Total	25	100%

Table (3.4): Shows the frequency of sex in control group (adults):

Sex	**Frequency**	**Percent**
Male	18	60%
Female	12	40%
Total	30	100%

Table (3.5): Shows the mean and STD.D of age (case group):

Age	Mean	STD.D	Frequency	Percent
Child	9	4.5	50	66.6%
Adult	24.6	5	25	33.4%
Total	33.6	9.5	75	100%

Table (3.6): Shows the mean and STD.D of age (control group):

Age	Mean	STD.D	Frequency	Percent
Child	8.6	4.3	20	40%
Adult	24.6	4.5	30	60%
Total	33.2	8.8	50	100%

Table (3.7): Shows the mean and STD.D of sodium and potassium in case group (children):

Valid	Mean	Std.Deviation	Frequency
Sodium (mmol/L)	134	7	50
Potassium (mmol/L)	3.6	0.6	50

Table (3.8): Shows the mean and STD.D of sodium and potassium in control group (children):

Valid	Mean	Std.Deviation	Frequency
Sodium (mmol/L)	140	3	20
Potassium (mmol/L)	4.2	0.5	20

Table (3.9): Shows the mean and STD.D of sodium and potassium levels in case group (adults):

Valid	Mean	Std.Deviation	Frequency
Sodium (mmol/L)	135	7	25
Potassium (mmol/L)	3.9	0.6	25

Table (3.10): Shows the mean and STD.D of sodium and Potassium in control group (adults):

Valid	Mean	Std.Deviation	Frequency
Sodium (mmol/L)	140	3	30
Potassium (mmol/L)	4.5	0.6	30

Table (3.11): Shows the mean and STD.D of sodium and potassium in case group (adult and children):

Valid	Mean	Std.Deviation	Frequency
Sodium (mmol/L)	134	7	75
Potassium (mmol/L)	3.7	0.6	75

Table (3.12): Shows the mean and STD.D of sodium and potassium in control group (adult and children):

Valid	Mean	Std.Deviation	Frequency
Sodium (mmol/L)	140	3	50
Potassium (mmol/L)	4.3	0.5	50

4. DISCUSSION

Sickle cell disease is an inherited disorder in which there is a point mutation arising from the substitution of glutamic acid by valine at the sixth position on the beta polypeptide chain .The balance of electrolytes in the body is essential for the normal functioning of the cells and organs. The mechanism by which sickling alter normal Na and K permeability is not clearly defined although it most likely is due to physical distortion of normal cation permeability barriers.

This case control study was conducted on the period from August to October 2017 at Kosti and Rabak teaching hospitals ,White Nile state in Sudan , with study population of 75 patients with SCA and 50 healthy controls .In this study the plasma sodium and potassium levels were compared between the control group subjects and case group subjects. Our study showed that the mean levels of sodium and potassium were significantly less in sickle cell disease group when compared with healthy controls group (134± 7mmol/L, 140±3mmol/L for sodium in case and control respectively while 3.7±0.6mmol/L, 4.3±0.57mmol/L for potassium in case and control group respectively) which was supported by the findings of JK Nnodim , *SC* Meludu , CE Dioka*et al*in in Nigeria (2014) , Divya Sudhir Tyagi, Pradeep Kumar Patra, Rahul Singh*et al* in India (2016) , Vikas Gupta, Ajay K. Singh, Jayant Saha*et al* in India (2012) and

Carlo Brugnarain in America (2000). Our study found that Hypokalemia (decrease potassium level) was observed in sickle cell anaemia patients compared with healthy controls was which was different from the results concluded by Agoreyo and Nwanze in Nigeria (2010) , Rasheed Yusuf, Abdulaziz Hassan, I. N. Ibrahim *et al* in Nigeria (2017) , Dr. Kavita A Madan , Dr. Sudhindra Baliga M, Dr. Nilima Thosar*et al* in India(2016) and Ajay W Meshram, Priyanka A Bhatkulkar ,Ruchir Khare *et al* in India (2014) who found hyperkalemia (increase potassium level) in SCA patients as compared with healthy controls.

5. CONCLUSIONS

In sickle cell anemia there are increased and continued obligatory losses of body fluids and electrolytes which rapidly result in dehydration and other metabolic disorders . In our study we observed that decreased electrolytes levels (sodium and potassium levels) in patients with sickle cell disease as compared with healthy controls probably depends on reduced fluid intake, accelerated influx and out flux of sodium and potassium.

Funding: Only the authors funded and supported this work

Conflicts of Interest: We declare, we have no conflict of interest

REFERENCES

[1] Agoreyo FO, Nwanze N, Plasma sodium and potassium changes in sickle cell Patients, International Journal of Genetics and Molecular Biology, 2, 2010, 014-019.

[2] Johnkennedy Nnodim. In vitro effect of Allopurinol on sickling rate and uric acid level in sickle cell erythrocyte. Asian Journal of Medical Science 2013; 4(2):30-32.

[3] Ballas, S.K., 2002. Sickle cell anemia: progress in pathogenesis and treatment. Drugs 62, 1143–1172.

[4] Samuel, R.E., Salmon, E.D., Briehl, R.W., 1990. Nucleation and growth of fibers and gel formation in sickle hemoglobin. Nature 345, 833–835.

[5] Urade BP, Hemoglobin S and ßThal: Their Distribution in Maharashtra, India, International Journal of Biomedical Sciences, 9, 2013, 75-81.

[6] Solomon, L.R. (2010) Pain Management in Adults with Sickle Cell Disease in a Medical Center Emergency Department. Journal of the National Medical Association, 102, 1025-1032.

[7] Vella F. Sickling in the Western Sudan. Sudan Med J 1964; 1:16–17.

[8]Lauder IR, Ibrahim SA. Sickling in south-west Kordofan. Sudan Med J 1970; 8:206–214.

[9]Kabins SA, Lerner C (1970). Sickle cell disease. JAMA 211: 467-468.

[10] Kaine WN, (1983). Morbidity of homozygous sickle cell anaemia in

Nigerian children J. Trop. Peadiatr. (2): 104-111.

[11] Harvey S (2002). Sickle cell disease: Editor in chief well connected reports:Associate professor of medicine, Harvard medical school. Massachusetts General Hospital.

[12] Pandey S, Sharma A, Biochemical Indicator of Sickle Cell Disease, Preliminary Report from India, Ind J ClinBiochem, 27, 2012,191-195.

[13] Oladipo OO, Temiye EO, Ezeaka VC, Obomanu P, Serum, magnesium, phosphate and calcium in Nigerian children with sickle cell disease, West Afr J Med, 24, 2005,120-3.

[14] Tosteson DC, Shea E, Darling RC, Potassium and sodium of red blood cells in sickle cell anemia, Journal of Clinical Investigation,31, 1952,406411.

[15] Statius LW, Schouten H, Sloof PA (1971). Sodium, potassium and calcium in erythrocytes in sickle cell anaemia. Clin. Chim. Acta 33: 475478.