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Biochemical changes associated with sickle cell anaemia

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ABSTRACT

Some blood chemical parameters including some enzyme activities were determined in forty two sickle cell patients in Ekiti state, Nigeria. All the parameters of interest analyzed for were found present in all the samples. The mean values for uric acid (0.35±0.16mol/l), creatinine (100.55±8.13µmol/l), urea (10.50±6.28mmol/l), Total bilirubin (14.42±2.03µmol/l), conjugated bilirubin (10.53±2.67µmol/l), alkaline phosphatase (82.67±10.87µ/l) aspartate transaminase (SGOT) (20.68±9.85µ/l) and alanine transaminase (SGPT) (28.68±9.85µ/L) were significantly higher ($P<0.05$) in sickle cell patients than the control. Serum sodium (Na^+) (110.00±4.0lmmol/L), potassium (K^+) (2.56±0.63mmol/L) total protein (60.05±10.35g/L), albumin (30.16±3.28g/L), Calcium (2.00±0.1mmol/L) and inorganic phosphate (1.12±0.19mmol/L) were also found to be significantly lowered in sickle cell patient when compared with the control. Analysis of the results showed an increase in plasma chloride (99.33±2.54mmol/L) and decrease in bicarbonate (22.99±2.06mmol/L). The differences were however not statistically significant ($P>0.05$). The significant raised level of SGPT, SGOT, ALP, total bilirubin, conjugated bilirubin, and significant lower levels of total protein, albumin, calcium, inorganic phosphate indicates that there may be abnormal liver and renal function as well as muscular and bone dysfunction in these patients.

Key words: Sickle cell, renal function and dysfunction.

INTRODUCTION

Sickle cell disease constitute one of the most frequent occurring hereditary conditions in the world. The disease is believed to have originated in Africa, thousands of years ago and most of the people afflicted today are African. It also occurs in areas where malaria has at one time been quite prevalent (Parveen and Michael, 1990).

Sickle cell disease is a genetic disease that occur as a result of a change in the sequence for the codon 6 of the β-chain from GAG in the normal gene to GTG in the sickle cell genes resulting in the substitution of valine for glutamic acid thereby producing a sickle shaped red blood cell (Lorraine and Sergeant, 2001).

The clinical signs and symptoms of sickle cell disease usually do not appear until after the sixth month of life at which time most of the HbF (foetal haemoglobin) has been replaced by sickle cell haemoglobin. Among the constitutional manifestation of sickle cell diseases are impairment of growth and development and a general failure to thrive (Robert et.al.1999).

The increased morbidity and mortality of sickle cell disease most especially in Ekiti State has prompted the current research work. In view of these, the present study reports some blood chemistry parameters of sickle cell patient in Ekiti State, Nigeria.

MATERIAL AND METHODS

Forty two sickle cell patients (30 females and 12 males) aged between 12 and 30 years and aged matched healthy people as control were used for the study. The controls had no clinical evidence

of sickle cell disease or other forms of diseases. All patients were attending clinics at the Ekiti State Specialist Hospital, (ESSH), Ado-Ekiti, Ekiti State, Nigeria.

6mls of venous blood were collected from each of the patients and the following parameters were analysed: sodium (Na^+), and potassium (K^+), were estimated using flame photometry techniques using Gallenkamp flame photometer (AOAC, 1990), chloride was determined by mercurimetric titration method (Schales and Schales, 1941), while bicarbonate was analysed using tritrimetric method (Henry et.al., 1974). Total and conjugated bilirubin were estimated by Jendrassik and Grof method (Tietz, 1986a), total protein determination was carried out using Biuret method described by (Peters and Doumas, 1982), albumin estimation was performed using Bromocresol Green (BCG) method of (Parveen and Michael, 1990); calcium was analysed by the O-cresolpthalein complexone method described by (Lorentz, 1982), inorganic phosphate determination was done by the monophosmolybdate method described by (Tietz, 1986b). Aspartate transaminase (SOPT) and alanine transaminase (SGPT) activities were determined by the method described by (Tietz, 1986c) and alkaline phosphatase was assayed using the method described by (Tietz and Rinker, 1986).

Statistical analysis

Results were expressed as mean $\pm$ standard deviation. The results were also analysed by using the student's 't' test.

RESULTS

The table below presents Mean and Standard deviations of sodium (Na^+), potassium (K^+), chloride, (Cl^-), bicarbonate ($H_2CO^-_3$), total bilirubin, total protein, albumin, calcium, inorganic phosphate, aspartate transaminase, (AST), alanine transaminase (ALT), and alkaline phosphate (ALP) of sickle cell patient and healthy controls.

Parameters	Sickle cell Patients	Controls
Sodium (Na^+) (mmol/L)	110±4.01	128±2.50
Potassium (K^+) (mmol/L)	2.56±0.63	4.01±0.23
Chloride (Cl^-) (mmol/L)	99.33±2.54	98.47±2.79
Bicarbonate ($H_2CO^-_3$)(mmol/L)	22.99±2.06	23.92±1.03
Total bilirubin (µmol/L)	14.42±2.03	6.90±1.26
Conjugated bilirubin (µmol/L)	10.53±16.67	2.70±1.17
Plasma Total protein (g/L)	60.05±10.35	66.06±4.30
Plasma Albumin (g/L)	30.16±3.28	50.15±2.20
Calcium (mmol/L)	2.00±0.14	2.58±0.02
Serum Inorganic phosphate (mmol/L)	1.42±0.19	1.42±0.09
Aspartate transaminase (SGOT) (µ/L)	20.42±10.94	7.28±2.91
Alanine transaminase (SGPT) (µ/L)	28.68±9.85	10.94±3.31
Alkaline phosphatase (µ/L)	82.67±10.87	62.00±2.00
Urea (mmol/L)	10.50±6.28	5.50±2.10
Uric acid (mmol/L)	0.35±0.16	0.14±0.03
Creatinine (ìmol/L)	100.55±8.13	80.15±1.11

DISCUSSION

The results obtained from this study showed that mean serum concentration of potassium (K^+) and sodium (Na^+) were significantly decreased ($P<0.05$) in sickle cell patients when compared with the values obtained for the controls. This was is agreement with the work of (Redal, et,al., 2001) who reported severe hyponatraemia in sickle cell disease. This decrease observed in the potassium and sodium levels in sickle cell patients might be due to increased urinary excretion of these

electrolytes and hypo-osmolality, since majority of these patient exhibit a salt wasting state and increased secretion of antidiuretic hormone most especially during crisis (Wilson and Alleyne, 2000).

The results show that the values of chloride and bicarbonate of sickle cell patients were not significantly different from their aged-matched healthy peers. This is indicative of absence of substance of acidosis. Total bilirubin and conjugated bilirubin were significantly raised (P<0.05) in sickle cell patients. These results support the report of higher total and conjugated bilirubin concentration (Lester and Schmid 2004) in sickle cell patient. This increase in total and conjugated bilirubin in sickle cell patient might be due to increased breakdown of red blood cells. The significantly lower levels of total protein and albumin indicates that the liver is damaged, therefore is not synthesizing normally. This compares favourably with the work of (Maclagan, 1999).

The mean serum transaminases (SGOT and SGPT) activities were found to be significant higher (P<0.05) in sickle cell patient. This increase might be due to the leakage of these enzymes from the cytoplasm and mitochondria of the liver tissue following hepatic injury which is common in sickle cell anaemia. (Latner and Skitten, 2002). The mean activity of Alkaline phosphatase (ALP) was also found to be significantly higher (P<0.05) in sickle cell patient than in normal subjects. This result supports the report of (Fishman, 2004). The increase in activity of ALP could be due to increased released of this enzyme from bone marrows and liver hepatocytes, hence, the weakness of the bones seen in sickle cell patients.

Calcium concentration was found to be significantly lower (P<0.05) in sickle cell patients than in normal controls. This supports the report of (Palek, 2003). This decrease in plasma calcium in sickle cell patients might be due to accumulation of calcium ions in the cell rather than in the blood. The plasma inorganic phosphate was found to be significantly lowered in sickle cell patients than in normal subjects. This increase might be due to increase in ALP activity. The plasma concentrations of urea and creatinine were significantly higher (P<0.05) in sickle cell patient than in the control, this might be due to excess body protein catabolism and muscular wasting respectively. Uric acid was also found to be significantly raised. This supports the findings of (Roswe, 2000). This indicates that there are abnormal renal and probably endocrinological processes supporting the sickled cell seen in these patients. The kidney tubules may have been damaged by excessive hormonal action of parathormone and vitamin D which may be acting in excessively compensatory amount to maintain normal plasma calcium and phosphate levels.

In general, the results, obtained from this study indicates liver and renal dysfuction in these patients as well as problem with bone metabolism.

These results will serve as baseline data for the clinicians in treating sickle cell diseases. For instance, hypertonic fluids can be administered to the patients and diet rich in protein and calcium can be recommended to complement treatment most especially during crisis.

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