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Research Article

Assessment of Serum Levels of Electrolytes and Trace Elements in Leukaemia Patients in Sudan

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Abstract

Electrolyte and trace elements disturbances frequently occur with leukaemia patients that complicate their management and prolong their hospitalization, due to either leukemic processes, organ infiltration, and cell death or to adverse effects of cytotoxic drugs. In this research work we investigated the interrelationship among different types of leukaemia with concentration of electrolyte and trace elements in Sudanese patients whose coming to the Radiation and Isotope Centre at Khartoum (RICK), Khartoum State; during the period June 2012 to August 2013. This work conducted on a total number of 201 subjects in which 79 were control participants and 122 were suffering from leukaemia and divided into four groups (ALL, AML, CLL and CML). Various electrolytes and trace elements were measured, including sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), Phosphate (PO_4^{3-}), trace elements zinc (Zn), copper (Cu), manganese (Mn) and cobalt (Co) in leukemic patients. Results show that a significant decrease in serum concentration of Ca, Zn, Cu, Co and Mn, significant increase in serum level of Mg. There is no significant difference between the levels of Na, K and PO_4^{3-} in leukaemia patients and control.

Keywords: Electrolytes; Trace Elements; Acute Leukaemia; Chronic Leukaemia

Introduction

Cancer is becoming a global health problem and the number of cancer cases in Africa is rising. Being an African country, Sudan has its share of cancer burden [1]. Sudan, the largest and most diverse country in Africa, is experiencing a growing cancer problem is little presently known on tumors patterns, cancer epidemiology and ethnic or environmental risk factors [2]. There were 322 children with cancer in Sudan from hospital registry for the period 1999 to 2007, 83.26% are diagnosed as leukemic [3]. Leukaemia's is defined as the uncontrollable production of white blood cells. Leukaemia's are divided into two categories; lymphocytic and myelogenous leukaemia's. Cancerous production of lymphoid cells, which is beginning in a lymph node or other lymphatic tissue is characteristic of lymphocytic leukaemia's, usually it spreads to all of the body. The second kind of leukemia begins with cancerous production of young myelogenous cells in the bone marrow and then spreads throughout the body so that white blood cells are produced outside the bone marrow in extramedullary tissues especially in the lymph nodes, spleen, and liver [4]. Trace elements have an important role within human body such as protection against cellular oxidative stress, production of proteins and synthesis and structural stabilization of nucleic acids. Over recent years many studies done if the trace elements have any effect in the etiology of neoplastic disease and in alteration of antioxidants levels [5].

Patients and Methods

The control group consisted of 79 healthy subjects (55 males and 24 females). The study group included 122 who diagnosed as leukemic patients (78 males and 44 females), their aged from less than one year to over 45 years. The study collect serum samples from patients coming to the Radiation and Isotope Center at Khartoum (RICK), Khartoum State. All the patients were enrolled in the study receiving treatment before the analysis was made. Among these patients, 72 of them had acute lymphoid leukemia (ALL), 17 patients had acute myeloid leukaemia (AML), 27 patients had chronic myeloid leukaemia (CML), and six patients had chronic lymphoid leukaemia (CLL).

Measurement the levels of electrolytes sodium and potassium by Easy Lyte analyser (Medica Corporation, USA). Magnesium, Calcium and phosphorus levels measured by spectrophotometer

instrument by using kits from Biosystems chemical company. Serum concentrations of Cu, Zn, Co and Mn in both patients and controls were determined by using atomic absorption spectrophotometer (Buck Scientific 210 VGP. USA, 2005).

Statistical Analysis

SPSS was used for statistical analysis. Results were expressed by mean and standard deviation and the correlations between various parameters and different subgroups were also determined. P < 0.05 was considered as statistical significance.

Results and Discussion

The leukemic subjects were classified into different sub types and showed a highly significant difference among themselves and with controls. The results are summarized in table 1. According to the present study our results showed that serum magnesium level in leukemia patients was significant higher in CML, AML and ALL (P > 0.01) when compared to the control. This agreed with [6] found increased in serum Mg in all patients. Elevated serum magnesium as a result of its release of malignant cells after cytotoxic therapy or its accumulation due to urate nephropathy [7].

Parameters	Control	Different types of leukemia			
		CLL	CML	AML	ALL
Na (mg/dl)	141.07 $^{a\,b}$ ± 0.57	134.78 $^{a\,b}$ ± 0.66	137.49 ^{a} ± 0.86	143.18 ^{b} ± 2.22	142.41 $^{a\,b}$ ± 1.94
K (mg/dl)	3.95 ^{a} ± 0.04	4.27 ^{a} ± 0.85	4.13 ^{a} ± 0.13	4.19 ^{a} ± 0.17	4.03 ^{a} ± 0.09
Ca (mg/dl)	9.62 ^{a} ± 0.14	8.82 ^{b} ± 0.70	8.40 ^{c} ± 0.13	9.48 $^{a\,b}$ ± 0.25	9.03 ^{b} ± 0.19
Mg (mg/dl)	2.15 ^{a} ± 0.03	1.83 ^{a} ± 0.14	2.73 ^{b} ± 0.10	2.52 ^{b} ± 0.10	2.48 ^{b} ± 0.08
P(mg/dl)	3.74 ^{a} ± 0.10	3.89 ^{a} ± 1.01	4.14 ^{a} ± 0.16	3.82 ^{a} ± 0.23	4.03 ^{a} ± 0.15
Cu (mg/dl)	0.89 ^{a} ± 0.02	0.46 ^{b} ± 0.14	0.53 ^{b} ± 0.06	0.53 ^{b} ± 0.08	0.62 ^{b} ± 0.04
Zn (mg/dl)	0.57 ^{a} ± 0.02	0.30 ^{cb} ± 0.00	0.37 ^{cb} ± 0.03	0.54 $^{a\,b}$ ± 0.14	0.44 ^{b} ± .03
Mn (mg/dl)	0.34 ^{a} ± 0.03	0.22 ^{b} ± 0.02	0.21 ^{b} ± 0.03	0.20 ^{b} ± 0.03	0.26 ^{b} ± 0.02
Co (mg/dl)	0.46 ^{a} ± 0.02	0.14 ^{b} ± 0.05	0.12 ^{b} ± 0.02	0.22 ^{b} ± 0.04	0.15 ^{b} ± 0.02

Table 1: Levels of different parameters (electrolytes and trace elements) in different types of leukemia.

Table 1 means with the same letter are not significantly different from each other (p < 0.05). The data presented as the Mean ± SE.

Serum levels of Calcium were significantly lower with CML, CLL and ALL than in control (p < 0.001, p < 0.05and p < 0.05 respectively). In hematologic malignancy hypocalcemia is not common and results from various factors, including hypoalbuminemia, malabsorption, malnutrition, vitamin D deficiency and hypomagnesaemia, or chronic respiratory alkalosis. Tumor lysis with its high serum phosphorous concentrations caused deposition of calcium-phosphate, thereby lowering serum calcium levels [8]. The use of anticancer drugs is beneficial for patients with malignancies but is usually associated with the electrolyte disorders such as hyper phosphoremia, hyperkalaemia and hypocalcaemia [9].

Regarding to the nutritional role of copper and zinc and their important roles in metabolism regulation and their direct relation with cancers any significant changes in the level of these elements could be harmful to the body [10]. In this study we observed that the decreasing serum zinc concentration in the leukemic group (CLL, CML and ALL) (p < 0.05) compared with control is in agreement with previous data. The general trend towards slightly decreased zinc concentrations in malignant diseases agree with the experimental results obtained by [11] implying that zinc deficiency is associated with the etiology of cancer.

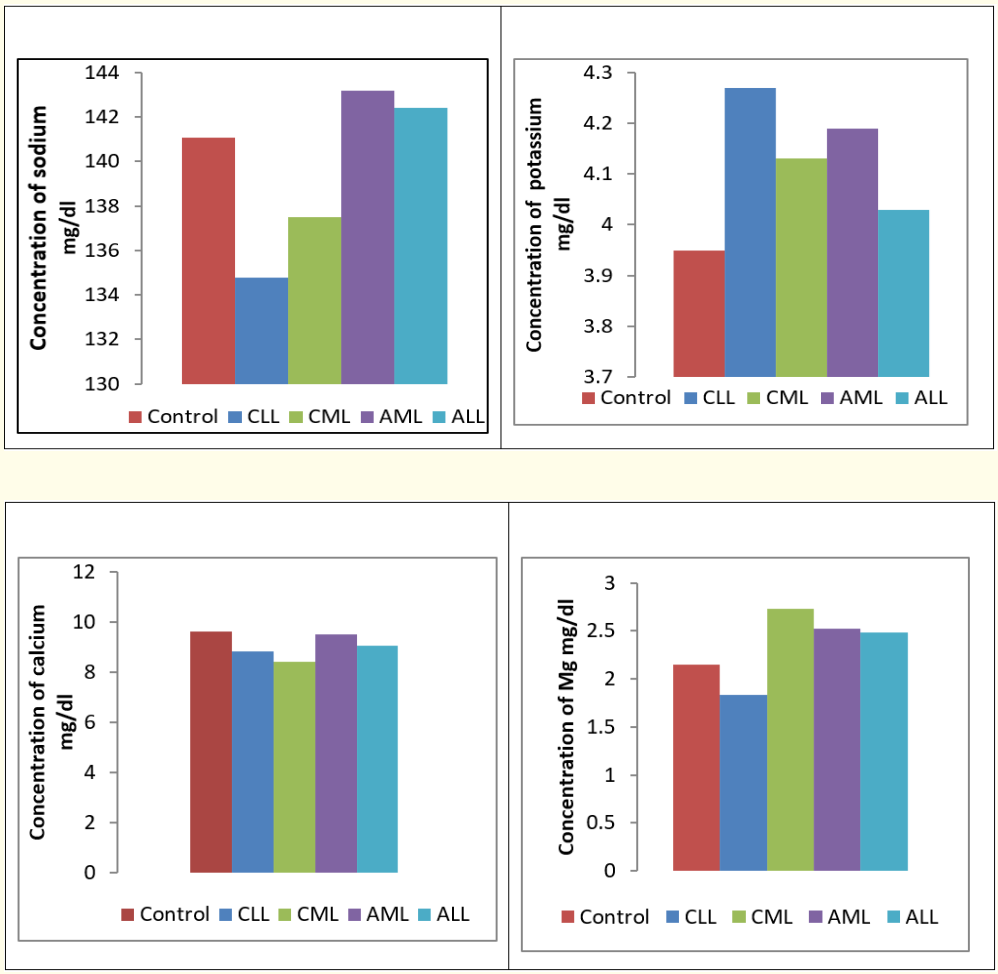
The variation in serum copper concentration were found in patients with leukaemia [12]. In the present study we observed decrease in copper concentration (p < 0.01) in all types of leukemia compared with control. Some investigators combined between copper deficiency and hematological and neurological abnormalities, they consider copper deficiency is an established cause of hematological abnormalities but is frequently misdiagnosed [13].

Manganese (Mn) is necessary for optimal biological function that is required as a cofactor for many enzymes [14]. Manganese-assisted enzymatic antioxidant Mn-superoxide dismutase (Mn SOD) is an endogenous antioxidant enzyme it is function neutralize free radicals and prevent cellular damage by catalyses the dismutation of superoxide radicals, producing hydrogen peroxide and oxygen [15]. In the current study, serum manganese showed significantly lower concentration in all groups CML, CLL, AML and ALL ($p < 0.05$) of leukaemia patients than control. Reactive oxygen species (ROS) have been shown to be included in tumor promotion, whereas antioxidant defences may have an anticarcinogenic action. Evidence suggests that superoxide or hydrogen peroxide can affect the growth, moreover, animal cells death. Studies demonstrated that relatively low levels of oxidative stress, stimulate cellular proliferation rather than causing degeneration or death. Increasing in free radical generation in leukaemic patients and decreasing in the antioxidant defences are indicative of oxidative stress involved in the pathogenesis of human leukaemia [16].

Cobalt is essential to mammals in the form of cobalamin (vitamin B12) [17]. Significantly lower concentration of cobalt in all groups; CML, CLL, AML and ALL ($p < 0.05$). Deficiency of cobalt leads to decreased availability of B12, and developed many symptoms and problems attributed to B12 deficiency, particularly pernicious anemia, nerve damage and a significant increase in the incidence of lymphatic and hematopoietic malignancies [18].

Many studies showed a low serum level of sodium (hyponatremia) and potassium (hypokalaemia) [19,20] were not observed in ours. Patients in remission usually have normal serum electrolyte concentrations [7].

Na, Mg, Cu, Zn showed significant variation in their levels within different groups.



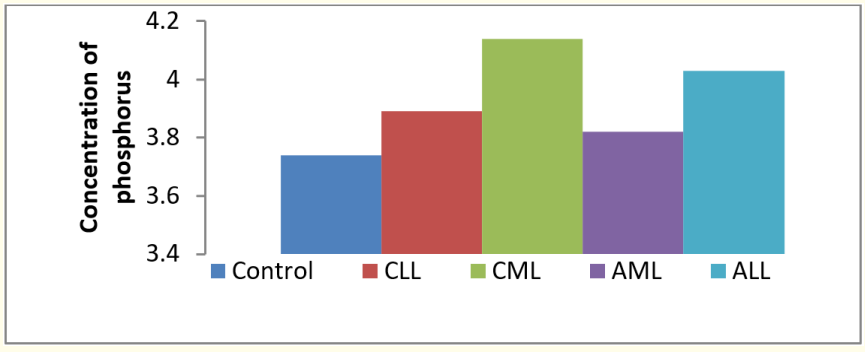


Figure 1: Concentration of Na, K, Mg, Ca and PO_4^{-3}.

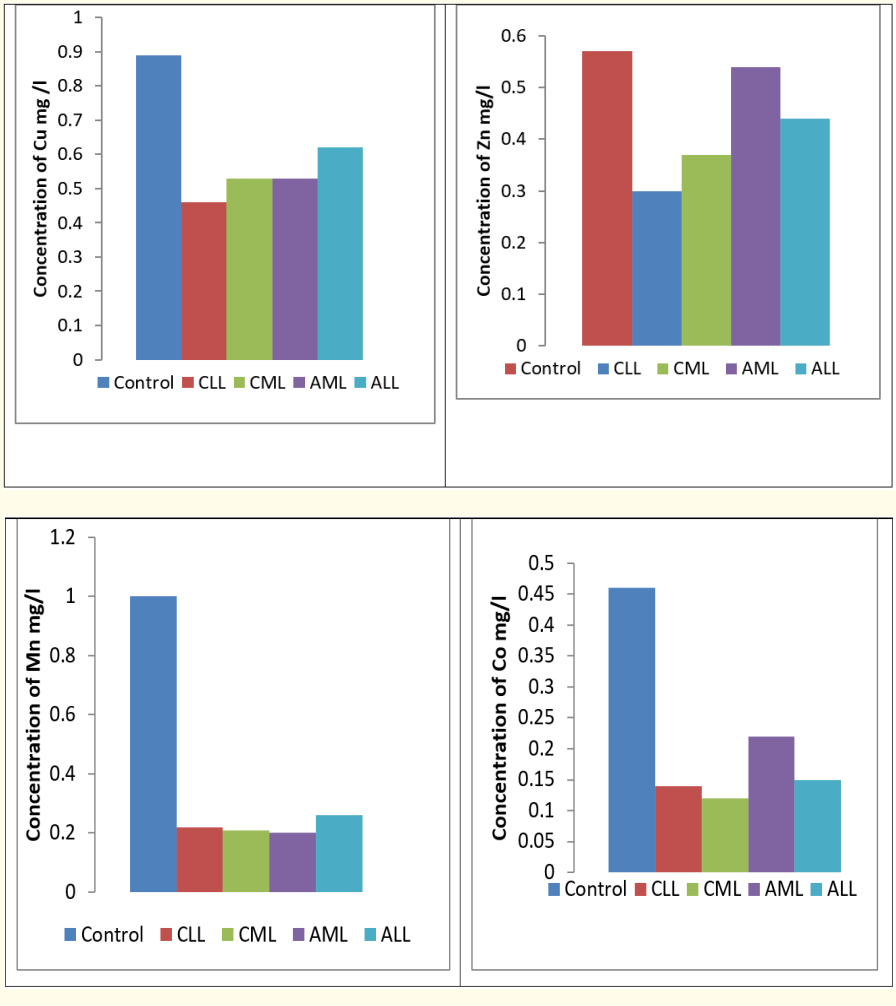


Figure 2: Concentration of Cu, Zn, Mn and Co in subtypes of leukemia.

Conclusion

- Electrolyte abnormalities common and recognizable features in cancer patients but not observed in our study, some study attributed electrolyte abnormalities with drinking demineralized tap water. fortunately, in Sudan, we used the natural water as drinking water may be this the reason for normal electrolytes in leukaemia patients.

- Electrolyte disorders in patients with cancer are common and can be secondary to either the cancer or its therapy more studies need to confirm the possibility of using these elements as the diagnosis or prognosis tool of the leukemia disease.

- Trace elements have an important role in biological processes as they consider as cofactors for many enzymes, included antioxidant enzymes. A deficiency of these trace elements can influence the level of oxidative stress causing increase of free radicals and increased their adverse effect on cell proliferation and direct effects on DNA, leading to genetic mutations or genomic damage.

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