LEUKEMIA; ALTERATION IN SERUM ELECTROLYTE (NA^+, K^+, MG^{+2}, CL^- AND PO_4^{-3}) LEVELS

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MISS KALSOOM
Assistant Professor
Institute of Molecular Biology & Biotechnology (IMBB)
The University of Lahore

DR. FARAH DEEBA KHAN
Assistant Professor
University College of Medicine & Dentistry
The University of Lahore-Pakistan.

MISS SONIA NOREEN
Institute of Molecular Biology & Biotechnology (IMBB)
The University of Lahore

Mr. M. Zaigham Javed
Institute of Molecular Biology & Biotechnology (IMBB)
The University of Lahore

ABSTRACT... The present work was undertaken to analyze qualitatively the serum electrolyte (K^+, Na^+, Mg^{2+}, $PO4^{3-}$ and Cl^-) levels by photometric analysis in cancer patients as compared to non-cancer individuals. An understanding of the mechanisms involved in disease pathogenesis is paramount for prevention and treatment in cancer patients. **Material and Methods:** Total 120 blood samples were collected for analysis randomly which were divided into two groups as A (leukemia patients) and B (normal individuals) having 60 in each. Both of these groups were further sub-divided (20 each) into three age groups (20-35, 36-50 and 51-70) A1, B1, A2, B2, A3, B3 respectively. **Results:** A significant ($p<0.05$) increase in serum K^+ level (hyperkalemia) was observed in cancer patients as compared to normal individuals having a non significant ($P>0.05$) interaction with the age limits. However a significant decrease ($P<0.05$) in the levels of Mg^{2+}, $PO4^{3-}$ and Cl^- (hypomagnesia, h pophosphatemia and hypochloridemia respectively) was recorded in group B as compared to group A having independency of age limits. **Conclusion:** Low serum Na^+ (hyponatremia) was observed in Group B3 as compared to Group A3 (51-70) except the age limits (20-35 and 36-50) which showed a non significant interaction with this decreased level of sodium. The data was statistically analyzed by ANOVA and a highly significant ($P< 0.05$) difference was obtained between both of the groups.

Key words: Pathogenesis, hyperkalemia, hypomagnesemia, hpophosphatemia, hypochloridemia and hyponatremia

INTRODUCTION

Cancer is fundamentally a disease of failure of regulation of tissue growth. Normal cells in the body have an orderly path of growth, division and programmed cell death also referred as apoptosis. In contrast to normal cells, cancer cells do not perceive programmatic death, instead continue to grow and divide. This leads to a mass of abnormal cells deviating from the audit[1]. Leukaemia is a common type of cancer after lung, breast and prostate, accounting for about 30% of all cancers. It is estimated that 47,150 men and women (26,830 men and 20,320 women) will be diagnosed with and 23,540 men and women will die of leukemia in 2012[2].These patients frequently exhibit acid base and electrolyte disturbances that complicate management and prolong their stay in hospital[3]. The mechanisms for these anomalies are multi-factorial in origin. Both the underlying disease and the therapeutic interventions can contribute to the development of such disturbances[4]. An understanding of the mechanisms involved in disease pathogenesis is paramount for prevention and treatment in cancer patients[5]. Oncological emergencies are life-threatening complications that can be presented during the due course of the disease or associated with the therapeutic modalities of malignant diseases. If these were diagnosed and be treated right away, improved quality of life could be obtained[6].

Life-threatening complications noticed in metabolic cancer patients are: hypercalcaemia, hyponatremia, tumor lysis syndrome (TLC), lactic acidosis and kidney failure[7]. TLS contributes to the assemblage of electrolyte abnormalities caused by the rapid and the immediate release of intracellular contents into the blood stream. The release of intracellular potassium and organic/inorganic phosphate in the blood cells results in the evolution of hyperkalemia and hyperphosphatemia, respectively[8]. Serious hyperleucocytosis may significantly affect the results of laboratory analysis of serum potassium and phosphate levels as well as blood oxygen tension. Apart from this hyperleucocytosis, initial blood tests show hypokalemia, hypophosphatemia, and severe hypoxemia without any relevant complaints[9].

MATERIALS AND METHOD

The work was conducted to analyze the serum

electrolyte (K^+, Na^+, Mg^{2+}, $PO4^{3-}$ and Cl^-) levels by photometric analysis in the patients of leukemia. Total 120 blood samples were collected for analysis under two groups as A (leukemia patients) and B (normal individuals) having 60 samples in each.

5 ml blood was collected randomly from all individuals (normal and patients of leukemia). The serum was then separated by centrifugation at 3000 rpm for 10 minutes and was subjected to analyses via kit method using photometric analysis.

RESULTS

Following results were recorded after the blood analysis for the given electrolytes. The data were subjected to analysis of variance using a COSTAT computer package[10]. The mean values were compared with the least significance difference test following Snedecor and Cochran[11].

DISCUSSION

The present experimental work was aimed to investigate the effect of cancer on serum electrolyte (K^+, Na^+, Mg^{2+}, $PO4^{3-}$ and Cl^-) levels in association with different age groups (20-35, 36-50 and 51-70). It has been reported that the mechanisms encountered for these abnormalities are multifactorial in origin.

Significant ($p<0.05$) increase in serum potassium level was observed in cancer patients as compared to the controls showing independency of the all the age limits (20-35, 36-50 and 51-70) on the increase of serum potassium levels (Table No. I). While a significant ($p<0.05$) decrease in serum electrolytes Mg^{2+}, $PO4^{3-}$ and Cl^- was observed in the group B as compared to group A

Table-I. Estimation of Serum Electrolyte Levels

Serum Electrolytes	Age	Groups		Significance level (P-value)
		Control Group A	Cases Group B	
Serum sodium level	20-35	140.48	116.66	0.014*
	36-50	138.54	114.11	0.000***
	51-70	140.57	117.26	0.647^{ns}
Serum potassium level	20-35	4.324	6.34	0.000***
	36-50	4.43	6.33	0.000***
	51-70	4.33	5.98	0.000***
Serum magnesium level	20-35	2.098	0.91	0.000***
	36-50	2.09	0.88	0.043*
	51-70	1.69	0.89	0.047*
Serum phosphate level	20-35	3.502	1.68	0.000***
	36-50	3.28	1.861	0.063*
	51-70	3.652	1.78	0.045*
Serum chloride level	20-35	110.775	96.82	0.000***
	36-50	109.6	96.5	0.014*
	51-70	110.26	96.8	0.01*

**(Significant), ** (Highly Significant) ns(non-significant) Significance level = (p=<0 .05)*

(control) having a non significant ($p>0.05$) interaction with the age limits (20-35, 36-50 and 51-70) showing independency of age limits on the decreased values of Mg^{2+}, $PO4^{3-}$ and Cl^{-} levels (Table No.I). This was in agreement with the work of Shibata[12], 2010) where they observed hyperkalemia, hypomagnesemia, hypomagnesia, hypomagnesemia in advanced cancer patients. This shows that hyperkalemia and hypomagnesia with the use of monoclonal antibodies and chemotherapy is occasionally induced for very large malignant tumors due to tumor lysis syndrome. These disorders could be morbid or even motile, resulting from encephalopathy or arrhythmia in some cases. In addition, small molecular targeted drugs, such as m-TOR inhibitors and ABL kinase inhibitors, also exert adverse reactions including hypomagnesemia and hypophosphatemia.

The increased levels of potassium observed in cancer patients could be due to administration of mannitol during craniotomy as reported by Tobita et al[13] who explained that the blood potassium levels rose from 4.8 mEq/L to 6.7 mEq/L 30 minutes after the infusion of mannitol 300 ml during the surgical removal of brain tumor. Since the patient did not develop metabolic acidosis, the hyperkalemia was probably caused by a rise in plasma osmotic pressure resulting from mannitol infusion. According to Davidson et al[14] hyperkalemia may appear from 6 to 72 hrs after the initiation of chemotherapy and is the most serious manifestation of tumor-lysis syndrome. Cell lysis results in the liberation of large amounts of intracellular potassium into the extracellular fluid causing an increase in serum potassium level. A decrease in serum potassium, mainly owing to lysozyme-induced tubular damage, appears to be one of the most frequent and potentially hazardous abnormalities. Other clinically significant metabolic perturbations include hyponatremia and hypercalcemia.

Significant low phosphate level in cancer patients was observed as compared to the normal individuals (Table No.I). Pelger et al[15] also described the same results with the explanation that a low plasma phosphate could be associated with inappropriately increased urinary phosphate loss, normal plasma calcium concentrations, and low 1, 25-dihydroxy-vitamin D, indicating a defect in the synthetic capacity of renal one-alpha hydroxylase enzyme. Cancer patients with oncogenic osteomalacia commonly exhibit profound hypophosphatemia due to renal phosphate wasting as inferred by Carpenter[16]. Hypomagnesemia that was observed in serum could be due to cisplatin as reported by Nazneen et al[17].

A significantly low serum sodium level i.e. hyponatremia was observed in Group B as compared to Group A in the present study. Out of all three age limits (20-35, 36-50 and 51-70) the first two age limits (20-35 and 36-50) showed an independency of age factor on the decreased level of serum sodium while the age limit (51-70) showed that there was a significant interaction of the age limit with this decrease in sodium concentration (Table No. I) which might be associated with SIADH in cancer patient at this older age. It was presumptively caused by true volume depletion, being a potent stimulus to vasopressin (ADH) release leading to hyponatremia as explained by Konstantino[18]. A decrease in serum potassium is mainly due to lysozyme-induced tubular damage that is inconsistence with the work done by Fillipattos et al[9]. Other reasons may include salt wasting nephropathy associated with cisplatin or ifosfamide tubular toxicity; with adrenal insufficiency due to tumor metastasis at both adrenal glands or with cerebral salt wasting, which have been described in patients with intracranial metastases. Syndrome of inappropriate antidiuretic hormone (SIADH) could also be a common cause of hyponatremia in cancer patients as deduced by Sorenson et al[20,21].

CONCLUSIONS

It was concluded from the outcomes of the present study that manifestation of cancer is associated with significant alteration of serum electrolyte levels, as drastic significant reduction in serum magnesium, phosphate sodium and chloride and significantly elevated levels of serum potassium levels were observed in individuals suffering from cancer as compared to normal individuals. The study provides directions for clinicians who should be vigilant for early detection and appropriate management of these disorders before the initiation of chemotherapy regimens as well as during treatment.

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Correspondence Address:
Dr. Farah Deeba Khan
Assistant Professor,
University College of Medicine & Dentistry
The University of Lahore-Pakistan
maddarch@yahoo.com

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