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Electrolytes and Nutritional Element Assessment among Iraqi Cancer Patients Receiving Chemotherapy

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Abstract

INTRODUCTION: Cancer may lead to abnormalities in electrolyte levels and acid-base disturbances in affected patients that could be induced by the tumor itself or by chemotherapy treatment. Thus, early detection is vital to improve short-term outcome and quality of life.

AIM: This study aims to assess the electrolyte and protein changes in cancer patients on chemotherapy.

MATERIALS AND METHODS: A cohort study was carried out on 100 newly diagnosed patients with cancer in Al-Amal National Radiation Oncology Hospital in Baghdad, Iraq, during the period from January 2019 to July 2019. An assessment of the studied samples was conducted as a baseline measure before receiving chemotherapy and after the third cycle of that treatment. Quantitative parameters included measurements of serum magnesium, calcium, sodium, chloride, potassium, zinc, Hb1Ac, total protein, and ferritin. Data analysis was carried out using Student's t-test for variable levels. Level of significance of ≤0.05 was considered as significant.

RESULTS: The studied sample comprised 77 females (77%) and 23 males (23%). There were significant decreases in the levels of magnesium and zinc while no significant changes were noted in the levels of other electrolytes. On the other hand, there was a significant decrease in the level of proteins and a significant rise in HBA1c and ferritin.

CONCLUSION: Cancer patients on chemotherapy regimens suffer from major changes in the levels of vitamins, elements, and neurotransmitter that affect their lifestyle, survival, and prognosis. Frequent regular monitoring of such changes is required to harvest a positive impact on the lifestyle of cancer patients lifestyle and their outcome.

Introduction

Cancers are a broad entity of complex diseases with an irregular pattern of cell growth that can invade or metastasize other areas of the organism. It is the world's leading cause of mortality with 9.6 million deaths reported in 2018. The most common causes of cancer related death are due to lung, breasts, stomach, and colonic cancers [1].

Acid-base and electrolyte disorders (AEDs) could affect human body disequilibrium involving malnutrition processes and endocrine dysfunction. The electrolyte disturbances could be mediated by the tumor pathology itself or by the treatment [2]. In the United States, the direct costs of treating the associated hyponatremia exceeded $1.6 billion per year [3].

Early detection and prompt correction of AEDs can improve patients' short-term outcome and quality of life [4]. However, the epidemiology of AEDs in cancer patients and its relationship with clinical outcomes requires further studies.

We aimed to assess the electrolyte and protein changes in cancer patients on chemotherapy.

Materials and Methods

A cohort study was carried out on 100 newly diagnosed patients with cancer before undergoing chemotherapy treatment in Al-Amal National Radiation Oncology Hospital in Baghdad, Iraq, during the period from January 2019 to July 2019. The study protocol was approved by the institutional review board in accordance with the principles of the Declaration of Helsinki. Assessments of the studied samples were conducted as a baseline measure before receiving chemotherapy or radiotherapy (designated as T0) and in the period after the third cycle of chemotherapy (termed as Tx).

Patients criteria for inclusion

The following criteria were included in the study:

(1) All newly diagnosed patients with cancer aged ≥18 years; (2) patients who did not yet start the first cycle of chemotherapy regimen; and (3) those who are in a competent mental and physical status and willing to participate in the study team.

Patient criteria for exclusion

The following criteria were excluded from the study:

(1) Patients who are already started the chemotherapy regiment; (2) patients who are unable to answer the questionnaires (due to physical or mental impairment); and (3) deteriorated performance status participants.

Quantitative dietary assessment

Anthropometric measurement included weight, height, and body mass index (BMI). Quantitative dietary assessment was made for: Magnesium, calcium, sodium, chloride, potassium, zinc, Hb1Ac, total protein and ferritin.

A hundred patients with Iraqi carcinoma of various types, grades, and stages have been sequentially evaluated before chemotherapy and radiotherapy, regardless of their chemical purposes (curative, neoadjuvant, adjuvant, or palliative). They were selected in the waiting room for a medical test at the cancer center in this hospital. The patients approval was confirmed by signing written formal consent. The follow-up time depending on the chemotherapy treatment was about 2–3 months. The chemical parameters were measured using ELISA technique.

Statistically, patients data were analyzed using SPSS software version 25. Descriptive statistics tabulated as mean, standard deviation, range, frequencies, and proportions. Paired Student's t-test for variables levels was done. Level of significance of ≤0.05 was considered as significant difference or correlation.

Results

Patients demographics and characteristics are summarized in Table 1.

Table 1: Demographic distribution and characteristics of the study population (n=100)

Variables		No (%)
Gender	Male	23 (23)
	Female	77 (77)
Age	<20	1 (1)
	20-40	21 (21)
	41-60	55 (55)
	>60	23 (23)
Occupation	Working	21 (21)
	Not working	77 (77)
	Student	2 (2)
Comorbidity	Present	38 (38)
	Not Present	62 (62)
BMI	Under-weight	5 (5)
	Normal	20 (20)
	Over-weight	30 (30)
	Obese	45 (45)
Type of cancer	Breast	55 (55)
	Colorectal	14 (14)
	Lung	11 (11)
	Ovary	5 (5)
	Bladder	5 (5)
	Stomach	2 (2)
	Lymphoma	2 (2)
	NPC	1 (1)
	Larynx	1 (1)
	Pancreas	1 (1)
	Prostate	1 (1)
	RCC	1 (1)
	Cervix	1 (1)

In general, females constituted 77% of the cohort. The mean age was 50.15 ± 13.08 years with a median of 50 years. Obesity was reported in 45% of the cohort. The top three malignancy in the cohort were breast cancer 55 (55%), 14% colorectal and 11% lung.

Eight different chemotherapeutic protocols were prescribed to patients according the primary malignancy included Adriamycin, cyclophosphamide and Taxen for 54% of the cohort, Carboplatin and Taxen for 16%, Xelox for14%, Gemcitabine for 5%, Taxen for 5%, 5FU and Cisplatin for 3%, ABVD for 2% and FOLFIRINOX for 1%.

As Table 2 shows, there has been significant reduction in the level of magnesium and zinc after chemotherapy course (P- value <0.0001). Subtle reduction was seen in the other electrolytes which were statically not significant.

Table 2: Concentration of electrolytes pre-and post-chemotherapy

Parameter (normal value)	Pre-chemotherapy	Post-chemotherapy	Paired t-test P-value
Magnesium (1.5–2.3 mg/dL)	2.22 ± 0.34 mg/dL	1.88 ± 0.36 mg/dL	<0.0001*
Calcium (8.7–10.2 mg/dL)	9.55 ± 0.63 mg/dL	9.40 ± 0.61 mg/dL	0.0798
Sodium (136–146 mmol/L)	136.98 ± 4.58 mmol/L	136.01 ± 4.75 mmol/L	0.1435
Chloride (102–109 mmol/L)	103.17 ± 2.54 mmol/L	103.85 ± 2.64 mmol/L	0.0848
Potassium (3.5–5 mmol/L)	4.64 ± 0.61 mmol/L	4.66 ± 0.57 mmol/L	0.8118
Zinc (75–120 μg/dL)	89.42 ± 13.37 μg/dL	78.51 ± 13.56 μg/dL	<0.0001*

Significant reduction in total protein level was seen post chemotherapy (P- value = <0.0001, Figure 1). There was also a marginal yet significant increase in the level of HbA1c post chemotherapy (P- value=0.0434, Figure 2).

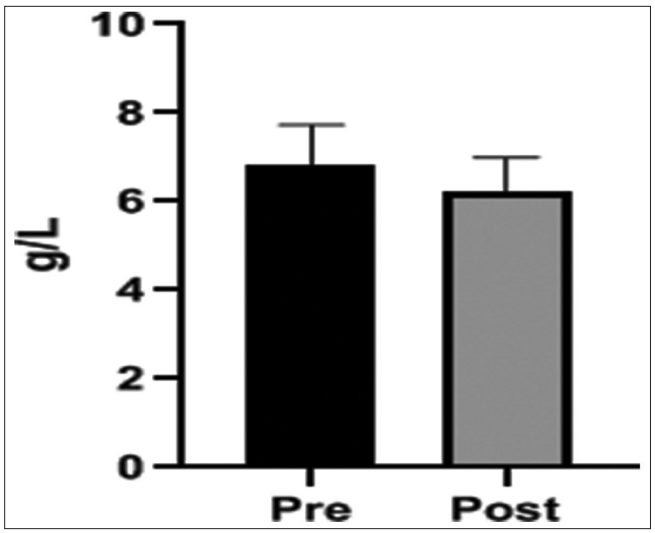

Figure 1: Total proteins concentration pre- and post-chemotherapy in terms of mean ± SD

Ferritin levels showed elevation in both males and females, however, the changes were statistically significant only in females (P- value = 0.0327 vs P-value = 0.3074, Figure 3).

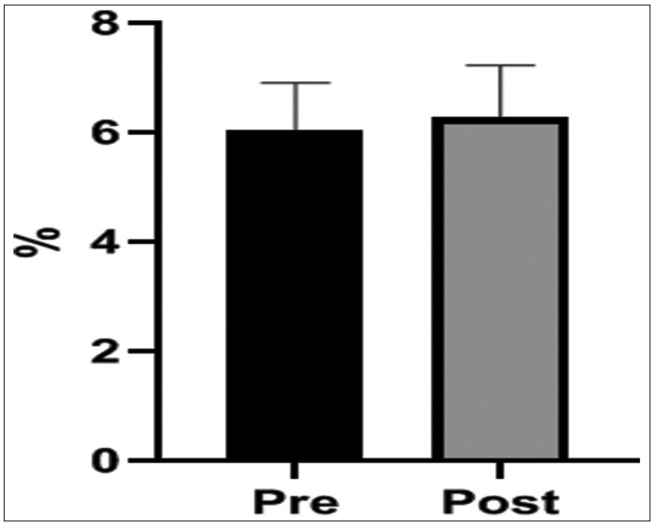

Figure 2: HbA1c concentration pre- and post-chemotherapy in terms of mean ± SD

Discussion

In our study, the recruited cancer patients comprised patients with various types, grades, and stages of cancer treated with different modalities.

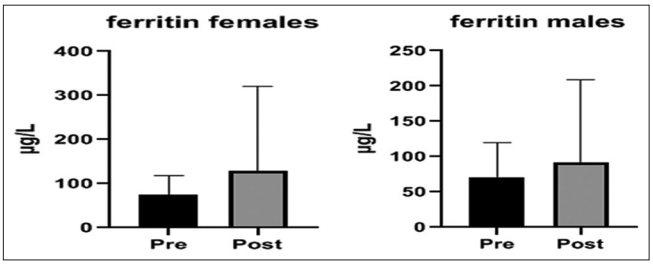

Figure 3: Ferritin concentration pre- and post-chemotherapy in terms of mean ± SD for females and males, respectively

The mean ± SD of the BMI of the patients was 30.62 ± 5.51 m^2/Kg with a median of 30.05 m^2/Kg. Overweight and moderate obesity were noted among 30% and 28%, respectively. On the other hand, severe obesity, underweight, and morbid obesity were displayed in 16.3%, 5%, and 1% of patients, respectively.

Magnesium levels showed a decrease with high statistical significance; similar findings were reported in another study [5]. This could be attributed to the effect of cytotoxic drugs (cisplatin) which impairs the renal tubular absorption of magnesium [6]. Similarly, a decline in the calcium rates was observed, though not significant, which could be secondary to hypomagnesemia [7], hypoalbuminemia [8], tumor lysis [9], [10], or hyperphosphatemia [11].

Hyponatremia may be attributed to cancer itself or treatment in cancer patients. Vincristine, ifosfamide, melphalane, and cyclophosphamide are reported to induce hyponatremia in chemotherapeutics through disrupting other hormones as cortisol. Nausea and pain typically recorded in patients with cancer can often promote the development of antidiuretic hormones and contribute to hyponatremia [12]. Serum chloride levels increased post-chemotherapy, with no statistical significance. Similar results were reported by other studies which have shown no significant change of serum chloride [13]. Chloride change follows sodium change as both are extracellular ions and should keep the balance of charges of extracellular environment neutral. There was a rise in this study with no statistical significance. Some studies have reported that platinum drug chemotherapy, for example, cisplatin, may mediate hypokalemia [14]. Ifosfamide induces potassium in renal wasting, either as a proximal isolated tubular disease or as Fanconi syndrome [15]. Extrarenal hypokalemia could be attributed to reduced appetites, diarrhea, and vomiting.

A statistical decrease was noted as well in serum levels of zinc that was consistent with numerous earlier studies [16]. Nutrients with strong anti-inflammatory properties such as Vitamin B6, magnesium, riboflavin, thiamine, zinc, and niacin have the ability to boost their anti-inflammatory cytokine profile and thus reduce the chances that certain patients have adverse health consequences [17]. Lower zinc levels may be also due to the decline of consumption. Cancer patients will excrete in their urine as much as 3 times more zinc than average persons [18]. Increased urinary zinc excretion may be associated with immune activation, renal tubular cell malfunction, and skeletal muscle catabolism in patients with cancer [19].

Protein levels in the studied patients revealed a significant decline following chemotherapy. The latter interfere with food intake and may exacerbate protein loss through urine due to inflammatory component [20]. Some studies have found a significant association between hypoalbuminemia and poor response to chemotherapy [21].

On the other hand, a statistical increase in serum levels of HbA1c after chemotherapy was observed using paired Student's t-test. Such results may be due to loss of lean body weight and sarcopenic obesity development. The most plausible cause appears to be a mix of tiredness, physical inactivity, altered appetite, and sarcopenic obesity that have a detrimental impact on insulin and glucose metabolism [22]. Glycemic control and the level of HbA1c are predictors for chemotherapy stoppage due to exacerbation of side effects or mediating a secondary infection. Likewise, a statistical increase in levels of serum ferritin was encountered among females. This could be due to release of ferritin from damaged liver cells as a consequence of chemotherapy [23]. Erythropoiesis suppression arising from cytotoxic treatment is likely to be at least partly responsible for this rise in serum iron [24]. Indeed, the situation is similar to that described with aplastic anemia induced by chloramphenicol, where a sudden increase in serum iron is a frontal sign of a bone marrow injury [25]. This is why the levels of ferritin are not associated with storage iron in such situations, a

finding which is particularly relevant for cancer patients [26]. In another research, serum ferritin as a reliable therapeutic biochemical marker has been implemented to assess survival for advanced hepatobiliary cancer patients [27]. Being a mediator of inflammation, interleukin-6 is known to increase in cases of cancer, especially post-chemotherapy through inducing iron regulatory hormone (hepcidin) [28].

Conclusion

Cancer patients on chemotherapy regimens suffer from major changes in the levels of vitamins, elements, and neurotransmitter levels that affect their lifestyle, treatment course, survival, and prognosis. Frequent regular monitoring for such changes is required to harvest a positive impact on the lifestyle of patients and the treatment outcome. Chemotherapeutic regimens need to be updated in terms of quality and quantity according to the peculiar status of the patient in terms of nutritional status and neurotransmitters changes.

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