Determination of Serum Trace Elements and Hematological Parameters in Lymphoma Patients Receiving Chemotherapy

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Abstract

Background

Trace elements are essential components of biological structures, some of them play an important role as anticancer and others can be toxic at concentrations beyond those necessary for their biological functions.

Aim

The objective is to examine changes in serum concentration of trace elements (Cobalt (Co), Germanium (Ge), Molybdenum (Mo), Nickel (Ni) and Vanadium (V)), Mg and hematological changes in Hodgkin and Non-Hodgkin lymphoma patients receiving therapy.

Materials and methods

The study was included 25 patients with Non-Hodgkin lymphoma (NHL) and 25 patients with Hodgkin lymphoma (HL) as compared with 50 healthy subjects.

Serum concentration of trace elements are measured by flame atomic absorption spectrophotometer. The total leukocyte count (TLC), hemoglobin concentration (Hb) and packed cell volume or hematocrit (Hct) are determined.

Results

Statistical analysis of data demonstrated significant decrease ($p<0.001$) in Mg and Co concentration and ($p<0.01$) in Ge concentration in patients with lymphomas receiving therapy as compared with healthy adults.

V and Ni concentrations are significantly increased ($p<0.001$) in patients with lymphomas receiving therapy as compared with healthy adults.

The study shows significant decrease ($p<0.05$) in Hb concentration and Hct percentage in patients with lymphomas receiving chemotherapy as compared with healthy subjects. It revealed significant decrease ($p<0.005$) in female patients with lymphoma who receive chemotherapy.

Significant decrease ($p<0.001$) in TLC in patients with lymphomas receiving therapy as compared with healthy adults are observed.

Conclusion

Lymphoma patients receiving therapy are often low in Mg, Ge and Co levels while Ni and V levels are high in patients with Hodgkin and Non-Hodgkin lymphoma.

There is a significant decreased in TLC in patients with Hodgkin and Non-Hodgkin lymphoma whose are receiving chemotherapy..

Anemia occurred in patient with lymphomas as a side effect of chemotherapy.

Key words: Hodgkin lymphoma, Non-Hodgkin lymphoma, trace elements, Hb, Hct, TLC, chemotherapy.

الخلاصة

تعتبر العناصر النزرة مركبات أساسية في البناء الحيوي والبعض منها يلعب دوراً مهماً كمضادات سرطانية والبعض الآخر يمكن ان يكون له تأثير سمي بالرغم من أهميته في الفعاليات الحيوية.

الهدف من الدراسة معرفة التغيرات في تراكيز العناصر النزرة (الكوبالت (Co) ، الجرمانيوم (Ge) ، الموليبدينوم (Mo) ، والنيكل (Ni) و الفاناديوم (V)) والمغنيسيوم (Mg) وكذلك التغيرات الدموية لدى مرضى سرطان الغدد اللمفاوية الهودجكني واللاهودجكني والمتلقين للعلاج الكيمياوي.

شملت الدراسة 25 مريضاً بسرطان الغدد اللمفاوية الهودجكني و25 مريضاً بسرطان الغدد اللمفاوية اللاهودجكني مقارنة مع الاصحاء (50 شخصاً). تم قياس تراكيز العناصر النزرة في مصل الدم بجهاز المطياف (flame atomic absorption spectrophotometer) كما تم قياس تركيز الهيموكلوبين (Hb) ونسبة مكداس الدم (Hct) والعدد الكلي لخلايا الدم البيض (TLC).

بين التحليل الاحصائي للعينات انخفاضاً معنوياً ($p<0.001$) في تركيز كل من Mg و Co وانخفاضاً معنوياً ($p<0.01$) في تركيز Ge لمرضى سرطان الغدد اللمفاوية لكلا النوعين والمتلقين للعلاج الكيمياوي مقارنة مع الاصحاء. كما ارتفع تركيز كل من Ni و V ($p<0.001$) لدى المرضى في هذه الدراسة.

اظهرت الدراسة انخفاضاً معنوياً ($p<0.05$) في تركيز الهيموكلوبين ونسبة مكداس الدم وانخفاضاً معنوياً ($p<0.001$) في العد الكلي لخلايا الدم البيض لدى مرضى سرطان الغدد المفاوية والمتلقين للعلاج الكيمياوي مقارنةً مع الاصحاء.

الاستنتاج: غالباً ما يكون تركيز كل من العناصر Mg و Ge و Co منخفضاً في مصل دم المرضى المصابين بسرطان الغدد اللمفاوية والمتلقين للعلاج الكيمياوي بينما يرتفع تركيز كل من Ni و V في مصلهم.

حصول انخفاض معنوي في العدد الكلي خلايا الدم البيض لمرضى سرطان الغدد اللمفاوية والمتلقين للعلاج الكيمياوي كما يظهر لديهم فقر دم كعارض جانبي نتيجة للغلاج الكيمياوي.

الكلمات المفتاحية: سرطان الغدد اللمفاوية الهودجكني واللاهودجكني, العناصر النزرة, تركيز الهيموكلوبين, ونسبة مكداس الدم, العدد الكلي لخلايا الدم البيض, العلاج الكيمياوي.

Introduction

Cancer is a significant and major health problem all over the world with incidence 10 million new cases per years (Dark & AbdulRazak, 2010). It was found that at least 350 people in babylon province/Iraq alone were affected by cancer every year (Al-Timimi & Al-Alwachi, 2005).

Lymphomas; cancer in lymphatic system, are solid tumors of the immune system (Shankland *et al*., 2012). Two types of lymphoma are classified; Hodgkin's disease develops from B-cells mutation and non-Hodgkin's lymphoma characterize proliferation of B-lymphocyte or T-lymphocyte (Szakács *et al*., 2010 ; Mader & Windelspecht, 2012)

Hodgkin's disease is infrequent malignant disease about 1% of cancers documented in developed countries annually (Bonadonna,2000 ; Yung & Linch, 2003). It is more frequent in men than women and high prevalence in young adults aged 15-40 years and in elder people over 55-60 years (Szakács, J. *et al*., 2010; Townsend & Linsh, 2012).

Non-Hodgkin's lymphoma mostly arise from B-cells (85-90%), others resulting from T-cells or natural killer lymphocytes. (Shankland *et al.*, 2012). Like Hodgkin's disease, non-Hodgkin's lymphoma is more frequent in men than women (Szakács *et al.*, 2010).

The most known risk factors for producing non-Hodgkin's lymphoma are immunosuppression, organ transplant recipient, and genetic immunodeficiency syndromes or autoimmune disease. (Hartge & Smith, 2007 ; Shankland *et al*., 2012).

The nature mechanism that protects against cancer is the immunity of human body. Trace elements represent vital processes in human health and disease in contribute in cellular and subcellular function including immunoregulation by both humoral and cellular immunity (Braverman & Pfeiffer, 1982; Mumtaz *et al*., 1999). In addition, trace elements considered anticarcinogenic agents by its antioxidant potential dependent enzyme, induction metallothionien, DNA repair and alternation of carcinogen metabolism (Al-Rawi & Talabani, 2005).

Cobalt (Co) is nutritionally essential metal as a part of vitamin B_{12} or cobalamin (Patil *et al*., 2013). It is found in very low levels (less than 0.1mg/kg) in food, deficiency of this rare elements probably cause pernicious anemia (Reilly, 2004). Co is necessary for the synthesis of thyroid hormone and beside iodine and other

chemical elements including Co found to influence thyroid goiters and then cancer (Zaichick *et al*., 1995). Co could be carcinogen, the mechanism of gene mutation by Co is DNA breaks and inhibition of DNA repair (Fukuda *et al*., 2004).

Germanium (Ge) is ultra-trace element found naturally in very low concentration in food especially meets and described as antioxidant and anticancer agent (Lück *et al*., 1999). It occurs mainly in human body in bone (9µg/g), liver (0.3µg/g) and pancreas (0.2µg/g) and it has been considered non-essential trace element as its molecules of biological importance is none identified (Strain & Cashman, 2009). Ge has believed to drop blood pressure and excite immunity to inhibit rheumatoid arthritis (Ali & Al-Zubaidi, 2012). Lück *et al*. (1999) mentioned that intake of Ge compounds causes renal failure, liver dysfunction and anemia.

Molybdenum (Mo) is nutritionally essential metal accumulated in human body in liver, kidney, bones and skin (Strain & Cashman, 2009). Several enzymes contains Mo including xathin oxidase and xanthin dehydrogenase; necessary for uric acid formation, and involved in purine degradation (Reilly, 2004). All foods and beverages (even water) contain Mo (Reilly, 2004; Strain & Cashman, 2009). Mo is considered as anti-cancer (Manuti *et al*., 2011). Its deficiency could be a reason for forming esophageal cancer (Braverman & Pfeiffer, 1982; Manuti *et al*., 2011), and development of thyroid goiters and cancer (Zaichick *et al*., 1995).

Nickel (Ni) is a trace metal with potential advantage effects (Patil *et al*., 2013) which has the ability to bind to many organic compounds of biological concern including amino acids; especially histidine and cysteine, and protein mainly albumin (Reilly, 2004; Strain & Cashman, 2009). Ni levels in food are low and can be seen in dried tea leaves, cacao beans and nuts (Reilly, 2004). Ni mainly found in adrenal glands, bones, kidney and thyroid. It has a role as a cofactor in metabolic pathway of vitamin B_{12} and folic acid (Strain & Cashman, 2009). Ni has been considered as important carcinogen (Ahmed *et al*., 2011). The deficiency of Nickel status includes a change in skin color, hormone imbalance and abnormal bone growth (Ali & Al-Zubaidi, 2012), and low growth and reproductive action (Jaryum *et al.*, 2010)

Vanadium (V) is a micronutrient element that has an important and distinctive role in human metabolism, found in cereals, meat, fish, vegetables and milk with daily intake about 10 µg-2mg (Reilly, 2004). High content of V in the body exist in bone, kidney, liver, spleen and testis. V has been believed to use iron transport system and bone is a storage part for excess vanadium (Strain & Cashman, 2009). It's important for bone, glucose and cholesterol metabolism and effect thyroid and dentin of tooth, high doses intake of V could cause vitamin C diminution (Ali & Al-Zubaidi, 2012; Al-Jedda & Al-Samarraie, 2012). Deficiency of V has been related with impaired reproduction and altered genesis of red blood cells and iron metabolism (Reilly, 2004). Also Jaryum *et al.* (2010) and Patil *et al*. (2013) mentioned that V deficiency can cause skeletal deformities and increasing of thyroid weight.

Magnesium (Mg) is an essential major mineral found in human body as a part of several enzymatic processes in intra- and extra- cellular components (Dhandapani *et al*., 2005), about 300 enzymatic reactions involve Mg: it plays important role in the stabilization of ATP and other molecules, glycolytic cycle, oxidation of fatty acids, protein synthesis (Gibney *et al.*, 2009; Poglitsch, 2009; Ali & Al-Zubaidi, 2012) and also plays an important role in carbohydrate metabolism (Khan *et al*., 1999). Mg is important in bone development and maintenance of bone, about 60% of Mg exisst in bone (Gibney *et al.*, 2009; Strain & Cashman, 2009), 38% in the skeletal muscle and liver, and less than 2% is in the extracellular fluid (Saif, 2008).

Mg provides elasticity to prevent injury and act with calcium to assist in muscle contraction, blood clotting and thought to regulate blood pressure (Poglitsch, 2009). Deficiency of Mg mentioned to be a contributor of tetany, calcium deficiency, development of cardiovascular disease, diabetes mellitus and hypertension (Strain & Cashman, 2009; Ali & Al-Zubaidi, 2012). Mg deficiency is more widespread in cancer patients than others (Saif, 2008).

Materials and Methods

Subjects

A random blood samples of 50 patients with lymphoma admitted to Merjian Teaching Hospital in Hilla city / Babylon governorate / Iraq were collected and compared with 50 healthy subjects.

Patients were enrolled their cancer diagnosis into different estimations of clinical biochemistry analysis and others clinical identification, they were diagnosed by a specialist physician at the hospital. They were grouped into two types of lymphoma; Non-Hodgkin lymphoma (NHL) and Hodgkin lymphoma (HD) as shown in the following table:

Subjects	Male (M)	Age mean (year)	Female (F)	Age mean (year)	Total
Healthy	25	34.59	25	36.14	**50**
NHL	15	48.84	10	47.5	**25**
HL	14	26.15	11	41.5	**25**
Total	54	-	46	-	**100**

Cancer patients were treated according to Herdrich & Weinberger (2003). Patients were received chemotherapy regime: doxorubicin or ciplatin, Endoxam, VCR, Adriamycin ADM, Mabthera for NHL and Bleomycin, VCR, Adriamycin ADM for HL.

Biochemical parameters

Serum concentration of Mg, Co, Ge, Mo, Ni and V are measured by using Shimadzu AA-700 atomic absorption spectrophotometer after digestion the sera with nitric acid, then injected into auto sample cup of instrument.

Hematological parameters

The white blood cells (WBC) counts and hemoglobin concentration are determined according to Dacie and Lewis (1984). The packed cell volume or hematocrit (Hct) was determined by the microhaematocrit method (Talib & Khurana, 1996).

Statistical analysis:

All data are subjected to t-test: tow sample assuming equal variance to determine the level of significance between healthy and patients with lymphoma. Data are reported as mean ± standard deviation (±SD). The significant differences were considered when p value were < 0.05, 0.01, 0.005 and 0.001.

Results

1. Concentration of trace elements

The results of concentration of trace elements (Co, Ge, Mo, Ni and V) in serum of patients with NHL and HL as compared with healthy subjects, as presented in Table 1.

Cobalt (Co):

Statistical analysis of data demonstrated significant decrease ($p<0.01$) in concentration of Co (0.0121 ± 0.0027 µmol/L) in patients with NHL as compared with healthy subjects (0.03955 ± 0.0555 µmol/L) and significant decrease ($p<0.005$) in concentration of Co (0.0117 ± 0.0033 µmol/L) in patients with HL as compared with healthy subjects (0.03955 ± 0.0555 µmol/L).

The study showed that the females are the most preferred (Table 2). There is significantly decreased ($p<0.05$) in concentration of Co (0.0121 ± 0.0033 & 0.0113 ± 0.0023 µmol/L) in female patients with NHL and HD respectively as compared with healthy females (0.0492 ± 0.0639 µmol/L).

Germanium (Ge):

The results (table 1) revealed significant decrease ($p<0.001$) in concentration of Ge (0.0336 ± 0.0121 & 0.0273 ± 0.0071 µmol/L) in patients with NHL and HL respectively as compared with healthy subjects (0.0512 ± 0.0198 µmol/L). Also the results articulated significant decrease ($p<0.001$) in concentration of Ge (0.0315 ± 0.0076 & 0.028 ± 0.0064 µmol/L) in female patients with NHL and HL respectively as compared with healthy females (0.0577 ± 0.0157).

Ge concentration in males with HL (0.027 ± 0.0074 µmol/L) is significantly decreased ($p<0.005$) as compared with healthy males (0.0447 ± 0.0214 µmol/L), as shown in Table (2).

Molybdenum (Mo):

The results showed (Table 2) significant increase ($p<0.05$) in concentration of Mo (0.00792 ± 0.0035 µmol/L) in females with NHL as compared with healthy females (0.01048 ± 0.0038 µmol/L).

Nickel (Ni):

In Table (1) statistical analysis of data demonstrated significant increase ($p<0.001$) in concentration of Ni (0.0132 ± 0.0046 & 0.0156 ± 0.0049 µmol/L) in patients with NHL and HL respectively as compared with healthy subjects (0.0106 ± 0.0014 µmol/L).

The results showed (Table 2) significant increase ($p<0.01$) in concentration of Ni (0.01431 ± 0.0051 µmol/L) in males with NHL as compared with healthy males (0.0115 ± 0.0011 µmol/L) as well as in concentration of Ni (0.0119 ± 0.0035µmol/L) in females with NHL as compared with healthy females (0.0098 ± 0.0011µmol/L).

The study revealed significant increase ($p<0.001$) in concentration of Ni (0.0159 ± 0.0048 µmol/L) in males with HL as compared with healthy males (0.0115 ± 0.0011 µmol/L) as well as in concentration of Ni (0.0151 ± 0.0049 µmol/L) in females with HD as compared with healthy females (0.0098 ± 0.0011 µmol/L).

Vanadium (V):

The results showed (Table 1) significant increase ($p<0.001$) in concentration of V (0.0107 ± 0.0016 & 0.0109 ± 0.0025 µmol/L) in patients with NHL and HL respectively as compared with healthy subjects (0.0090 ± 0.0010 µmol/L).

Table (2) showed significant increase ($p<0.001$) in concentration of V (0.0108 ± 0.0016 & 0.0114 ± 0.0024 µmol/L) in males with NHL and HL respectively as compared with healthy males (0.0089 ± 0.0010 µmol/L) as well as in concentration of V (0.0098±0.0026 µmol/L) in females with HL as compared with healthy females (0.0091 ± 0.0011 µmol/L). There is an increase ($p<0.01$) in the concentration of V

(0.0107 ± 0.0017 µmol/L) in females with NHL as compared with healthy females (0.0091 ± 0.0011 µmol/L).

Table (1): Concentration of trace elements in serum of patients with lymphoma receiving chemotherapy as compared with healthy subjects.

Subjects	Co (µmol/L)	Ge (µmol/L)	Mo (µmol/L)	Ni (µmol/L)	V (µmol/L)
Healthy	0.03955 ± 0.0555	0.0512 ± 0.0198	0.0104 ± 0.0029	0.0106 ± 0.0014	0.0090 ± 0.001
NHL	0.0121** ± 0.0027	0.0336†† ± 0.0121	0.0118 ± 0.0147	0.0132†† ± 0.0046	0.0107†† ± 0.0016
HL	0.0117† ± 0.0033	0.0273†† ± 0.0071	0.0106 ± 0.0014	0.0156†† ± 0.0049	0.0109†† ± 0.0025

Value expressed as mean ± S.D.
***** Significant differences at P< 0.05
****** Significant differences at P< 0.01
† Significant differences at P< 0.005
†† Significant differences at P< 0.001

Table (2): Concentration of trace elements in serum of patients with different types of cancers receiving chemotherapy as compared with healthy subjects according to sex.

Subjects	Co (µmol/L)		Ge (µmol/L)		Mo (µmol/L)		Ni (µmol/L)		V (µmol/L)	
	M	F	M	F	M	F	M	F	M	F
Healthy	0.0298 ± 0.0434	0.0492 ± 0.0639	0.0447 ± 0.0214	0.0577 ± 0.0157	0.01040 ± 0.0015	0.01048 ± 0.0038	0.0115 ± 0.0011	0.0098 ± 0.0011	0.0089 ± 0.0010	0.0091 ± 0.0011
NHL	0.012231 ± 0.0021	0.0121* ± 0.0033	0.035308 ± 0.0145	0.0315†† ± 0.0076	0.014846 ± 0.0188	0.00792* ± 0.0035	0.01431** ± 0.0051	0.0119** ± 0.0035	0.0108†† ± 0.0016	0.0107† ± 0.0017
HL	0.0119 ± 0.003792	0.0113* ± 0.0023	0.027† ± 0.0074	0.028†† ± 0.0064	0.0111 ± 0.0012	0.01 ± 0.0015	0.0159†† ± 0.0048	0.0151†† ± 0.0049	0.0114†† ± 0.0024	0.0098†† ± 0.0026

Value expressed as mean ± S.D.
***** Significant differences at P< 0.05
****** Significant differences at P< 0.01
† Significant differences at P< 0.005
†† Significant differences at P< 0.001

2. Concentration of Mg

Table (3) revealed significant increase ($p<0.001$) in concentration of Mg (13.43 ± 1.18 & 13.83 ± 1.39µmol/L) in patients with NHL and HL respectively as compared with healthy subjects (18.77 ± 2.10 µmol/L).

Table (3): Concentration of Mg in serum of patients with lymphoma receiving chemotherapy as compared with healthy subjects and according to sex.

Subjects	Mg (µmol/L)	Mg (µmol/L)	
		M	F
Healthy	18.77±2.10	19.51±2.39	18.03±1.42
NHL	13.43± 1.18††	13.52± 1.16††	13.32±1.18††
HL	13.83±1.39††	14.14±1.23 ††	13.34±1.49 ††

Value expressed as mean ± S.D.
†† Significant differences at P< 0.001

3. Hematological parameters

The study demonstrated significant decrease ($p<0.01$, $p<0.05$) in hemoglobin concentration (11.23 ± 2.09 & 12.46±1.78 g/100ml) of patients with NHL and HL respectively as compared with healthy subjects (12.37 ± 1.84 g/100ml) and significant decrease ($p<0.05$) in hematocrit percentage of patients with NHL (34.81 ± 6.29 %) as compared with healthy subjects (37.56 ± 4.15 %), as shown in Table (4).

Table (5) showed significant decrease ($p<0.005$) in hemoglobin concentration (10.18 ± 2.47 g/100ml) and hematocrit percentage (31.68 ± 7.89 %)of female patients with NHL as compared with healthy females (12.18 ± 1.29 g/100 ml & 37.07 ± 3.34 %) respectively.

Table (4) revealed significant decrease ($p<0.001$) in total leukocyte count (5.53 ± 3.54 µl) in patients with NHL as compared with healthy subjects (8.73 ± 2.59 x 10^3 µl).

Table (5) demonstrated significant decrease ($p<0.001$) in total leukocyte count (4.60 ± 2.33 & 6.89 ± 2.61 x 10^3 µl) in males with NHL and HL respectively as compared with healthy males (9.75 ± 2.13 x 10^3 µl) and significant decrease ($p<0.01$) in total leukocyte count (6.75 ± 4.38 x 10^3 µl) in females with NHL as compared with healthy females (7.71 ± 2.13 x 10^3 µl).

Table(4): Hematological parameters of patients with lymphoma receiving chemotherapy as compared with healthy subjects.

Subjects	Hb (g/100ml)	Hct (%)	TLC (x 10^3 µl)
Healthy	12.37±1.84	37.56±4.15	8.73±2.59
NHL	11.23±2.09**	34.81±6.29*	5.53±3.54††
HL	12.46±1.78*	37.48±5.48	7.75±3.57

Value expressed as mean ± S.D.
* Significant differences at P< 0.05
** Significant differences at P< 0.01
†† Significant differences at P< 0.001

Table(5): Hematological parameters of patients with lymphoma receiving chemotherapy as compared with healthy subjects according to sex.

Subjects	Hb (g/100ml)		Hct (%)		TLC (x 10^3 µl)	
	M	F	M	F	M	F
Healthy	12.56 ± 2.29	12.18 ± 1.29	38.05 ± 4.86	37.07 ± 3.34	9.75 ± 2.68	7.71 ± 2.13
NHL	12.04 ± 1.23	10.18† ± 2.47	37.23 ± 2.96	31.68† ± 7.89	4.60†† ± 2.33	6.75** ± 4.38
HL	12.84 ± 1.73	11.58* ± 1.672	39.31 ± 5.64	35.56 ± 4.29	6.89†† ± 2.61	9.15 ± 4.39

Value expressed as mean ± S.D.
* Significant differences at P< 0.05
** Significant differences at P< 0.01
† Significant differences at P< 0.005
†† Significant differences at P< 0.001

Discussion

The results of this study signify that serum Co concentration were decreased in patients with lymphoma whose receiving chemotherapy which agree with another research of cancer by Arooj *et al.* (2012); mentioned decreasing in the serum concentration of Co in breast cancer patients as compared to healthy women. Other studies of trace elements in saliva of oral cancer patients (Al-Rawi & Talabani, 2005) and thyroid tissue of thyroid cancer patients (Ziachick *et al*., 1995) reported an increase in Co levels. This variance of Co concentration reflects the alternation in metabolic routes in cancer patients as compared with other healthy subjects. Deficiency of essential elements Co may cause vitamin B_{12} deficiency since it is part of vitamin B_{12} (Reilly, 2005).

The data informed significant decrease in serum concentration of Ge in patients with lymphoma whose receiving chemotherapy. Ge deficiency could be a risk factor of cancer since Ge represents a powerful antioxidant against cancer by means of its activity to slow down the multiplication process of cancer hence inhibit tumor growth and enhance natural killer cells to act on (Singh *et al*., 2012).

According to the results of this study serum concentration of Ni is significantly increased in lymphoma patients receiving chemotherapy. Other study of trace elements and cancer found that Ni level in saliva of oral cancer patients was high as contrast with healthy people (Al-Rawi & Taabani, 2005). Ahmed *et al.* (2011) mentioned that the increased Ni concentration in esophageal cancer patients may play a role in carcinogenesis by preventing the intracellular communication and induces DNA deletion.

In addition to Ni, V is significantly increased in lymphoma patients receiving chemotherapy. V possibly exert an effect on oncogenes since it is also interferes with proper chromosome arrangement during cell division (Fukuda *et al*., 2004).

Mg is essential major mineral in human body as a part of 300 enzymatic processes (Gibney *et al.*, 2009; Poglitsch, 2009; Ali & Al-Zubaidi, 2012). The data of this study showed significant decrease in serum concentration of Mg in patients with lymphoma whose receiving chemotherapy which agree with another previous research in thyroid cancer patients (Al-Sayer *et al*., 2004). Al-Rawi & Taabani (2005) found significant reduction in Mg level in in saliva of oral cancer patients. In addition to cancer effect on Mg, anticancer drugs especially cause hypomagnesemia in cancer patients (Saif, 2008). Therapy with cytotoxic drugs may have impaired renal tubular reabsorption of Mg causing its loss in urine (Merza *et al*., 2008). Mg deficiency may trigger carcinogenesis by increasing membrane permeability of cancer cells and high level supplemented Mg inhibits carcinogenesis (Singh *et al*.,2012).

In summary our hematological results revealed that anemia is appeared in NHL and HL especially in females; hemoglobin (Hb) concentration and hematocrit (Hct) are significantly decreased in those patients as contrast with healthy subjects. This is supported by previous studies, Hb and Hct levels reduced in patients with carcinoma of the uterine cervix (Al-Araji & Hamad, 2005), in cachexia patients (Suker *et al*., 2012) and in patients with bladder cancer (Al-Muhammad *et al*., 2012). Moullet *et al*. (1998) referred that anemia is a common feature in non-Hodgkin's lymphoma. Autoimmune hemolytic anemia has been associated with Hodgkin's lymphoma (Riaz *et al*., 2010). Autoimmune hemolytic anemia is production of pathologic antibodies that attach to red blood cells and lead to its destruction causing anaemia (Shah *et al.*, 2013).

In this study, the total leukocyte count is significantly decreased in patients with lymphoma whose receiving chemotherapy. This is may be because of decreasing of neutrophil count. Han *et al*. (1998) mentioned that the white blood cells and neutrophils count are decreased in patients with solid tumors due to the cytotoxic cancer chemotherapeutic drugs. The most grave hematologic toxicity of cancer therapy is chemotherapy induced neutropenia (Friense, 2006). Also in study of hemolytic anemia and Hodgkin's lymphoma, Riaz *et al*. (2010) referred that immune neutropenia has been associated with Hodgkin's lymphoma.

Conclusion

Trace elements are essential in human body and play an important roles in many enzymatic metabolism. The summary of our study proposes that the levels of Mg, Co, Ge were reduced in patients receiving anticancer drugs (doxorubicin and ciplatin). These particular elements play an important role as anticarcinogenic agents and should get attention to the their levels in blood. While Ni and V levels are so high and should be aware to their toxicity effect at concentrations beyond those necessary for their biological functions.

There is a significant decreased in WBC count of patients with cancer in those who are receiving chemotherapy. Anemia occurred in patient Hodgkin's and non-Hodgkin's lymphoma especially women as a side effect of chemotherapy and one should get attention to this group of patients.

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