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Full Length Research Paper

Serum Magnesium and Copper levels were associated with Ambulation in Type 2 Diabetic Patients

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Abstract

Background: A relationship between diabetes mellitus (DM) and minerals is frequently reported, Alteration in the metabolism of trace elements like copper, magnesium is associated with DM. Alteration in mineral metabolism is more pronounced in diabetic populations with specific complications. Objectives: to estimate levels of magnesium and copper in serum of type 2 DM patients with amputation. Materials and methods: the study included eighty (80) subjects, (40) of them are with DM type 2 with complication, amputation (20), and (40) represent DM type 2 without complication groups. Magnesium, copper and HbA1c were estimated in the blood of all participants. Results: The mean concentration of copper was significantly increased among diabetic patient type 2 with complication compared to diabetic patient without complication *p-value* 0.012. The mean concentration of magnesium was significantly decreased among diabetic patient complication compared to a patient without complication *p-value* 0.011. Conclusion: Lower levels of magnesium and higher levels of copper were significantly associated with complications in type 2 diabetes mellitus.

Keywords: Type 2 DM, Magnesium, Copper, HbA1c, Amputation.

INTRODUCTION

Diabetes mellitus is characterized by hyperglycemia due to absolute or relative deficiency of insulin, Alberti and Zimmet, 1998, leading to impaired metabolism of carbohydrates, proteins, fats, water and electrolytes. The persistence of these metabolic disturbances leads to permanent and irreversible functional and structural changes in the cells of the body which in turn lead to the development of “diabetic complications”, characteristically affecting, the cardiovascular system, eye, kidney and nervous system mainly, Koda-Kimble and Carlisle, 1995.

Chronic complications of diabetes mellitus can be divided into vascular and nonvascular complications. The vascular complications of DM are further subdivided into micro vascular (retinopathy, neuropathy, nephropathy) and macro vascular complications [coronary artery disease (CAD), peripheral arterial disease (PAD), cerebrovascular disease]. Several of the complications of diabetes may be related to increased intracellular oxidants and free radicals Chausmer, 1998. Peripheral neuropathy (PN) and peripheral vascular disease (PVD) are well known common long-term complication of diabetes ,and although proportion of people with PN and PVD have sever debilitating pain ,many are symptomatic, Walter *et al.,* 1992. However ,despite the lack of symptoms people with PN and PVD are known to be at high risk of foot complication including foot ulceration ,infection and amputation Pecorar *et al.,* 1990; Adler *et al.,* 1999; Lehto *et al.,* 1996, PN and PVD are the main

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cause of non-traumatic lower limb amputation, Trauner *et al.,* 1996; Siitonen *et al.,* 1993.

A relationship between DM and minerals is frequently reported. Alteration in the metabolism of trace elements like copper, magnesium is associated with DM, Viktorínová *et al.,* 2009. Trace elements are accepted as essential for optimum health, because of their diverse metabolic characteristic and functions, Zargar *et al.,* 1998. Trace elements participate in production of reactive oxygen species (ROS), which contribute to oxidative stress. Oxidative stress contributes to the pathogenesis of many diseases including DM.

Trace elements are accepted as essential for optimum health, because of their diverse metabolic characteristic and functions Zargar *et al.,* 1998. Trace elements participate in production of reactive oxygen species (ROS), which contribute to oxidative stress. Oxidative stress contributes to the pathogenesis of many diseases including DM. Previous studies have shown that copper causes oxidative stress, Viktorínová *et al.,* 2009; Ankush *et al.,* 2009; Evliyaoglu *et al.,* 2004; Sarkar *et al.,* 2010. Copper acts as a pro oxidant and may participate in metal catalyzed formation of free radicals Viktorínová *et al.,* 2009. The increased production of free radicals is likely to be associated with development of type 2 DM.

Magnesium is an essential element involved in glucose homeostasis. It is a cofactor for various enzymes in carbohydrate metabolism. It is also involved at multiple levels in insulin secretion, binding and activity. Reduced level of magnesium has been documented in type 2 DM Viktorínová *et al.,* 2009; Zargar *et al.,* 1998; Ankush *et al.,* 2009; Evliyaoglu *et al.,* 2004. Hypomagnesaemia may have negative impact on glucose homeostasis and insulin sensitivity in type 2 DM patients, Hussain *et al.,* 2009 . Hypomagnesaemia may also have some effect in the development of diabetic complications with other risk factors. Keeping in mind the above facts, the aim of the present study was to evaluate the serum levels of copper, magnesium and glycated hemoglobin in patients type 2 DM with chronic complication (amputation) and compare it with patient non complication and also to assess the association of these minerals with glycated hemoglobin.

MATERIALS AND METHOD

In this cross sectional, eighty (80) subjects were enrolled, (40) them comprise DM type 2 with complication, amputation (50 %), and (40) represent DM type 2 with without complication groups (50 %), All subjects were DM type 2 , they were referred to Specialized Center in Khartoum state. Smoker, patient with liver disease, vitamin supplement, renal disease and Alcoholism were excluded from this study. Serum Mg, serum Cu and HbA1c, were measured among all study groups. Venous blood samples were collected and separated by centrifugation at (3000-4000 Rpm), to obtain serum that we stored at (-20 c^0) till used for measured of serum Mg and Cu, by used (Buck 210VGP atomic absorption spectrophotometer), and EDTA samples for estimation of HbA1c, by used Nyco Card™ READER II.

This study was approved by ethical committee of Alneelain University, college of medical laboratory sciences, department of clinical chemistry. Analysis was performed by means of statistical package for social science (SPSS) software version 21.

RESULTS

This study included 40 diabetic patient type 2 with complication and 40 diabetic patient type 2 without complication. The results show that, mean age of diabetic patient type 2 with complication (56.50±7.27) and diabetic patient type 2 without complication (53.77±8.92). In diabetic patient type 2 with complication were found (75%) male and (25%) female. In diabetic patient type 2 without complication were found (50%) male and (50%) female. This presented in table 3.1. The mean concentration of copper was significantly increased among diabetic patient type 2 with complication (0.196±0.049) in comparison with (0.162±0.066) diabetic patient type 2 without complication *p-value* 0.012. The mean concentration of magnesium was significantly decreased among diabetic patient type 2 with complication (14.04±2.61) in comparison with (15.77±3.27) diabetic patient type 2 without complication *p-value* 0.011. Also the results show significant difference increase in mean concentration of HbA1c in diabetic patient type 2 with complication (8.48±2.29) in comparison with diabetic patient type 2 without complication (7.56±1.61) with *p–value*. 0.041 Which presented in table 3.2.

Person's correlation showed, there is no correlation between serum copper level and HbA1c (r = -0.118, p-value 0.468) which presented in figure 1. Also correlation showed, serum magnesium level is inversely correlated with HbA1c (r = -0.413**, p-value 0.008) which presented in figure 2.

DISCUSSION

A relationship between DM and minerals is frequently reported. Alteration in the metabolism of trace elements like copper, magnesium is associated with DM (12). Trace elements are accepted as essential for optimum health, because of their diverse metabolic characteristic and functions (13). Trace elements participate in production of reactive oxygen species (ROS), which contribute to oxidative stress. Oxidative stress contributes to the pathogenesis of many diseases including DM.

Table 1. The general characteristics of diabetic patient

Parameters	DM with complication	DM without complication
Age (mean±SD)	56.50±7.27	53.77±8.92
Male (%)	30 (75%)	20 (50%)
Female (%)	10 (25%)	20 (50%)

Table 2. Mean concentration of Cu, Mg and Hb A 1C level among diabetic patient with complication and without complication

Parameters	DM with complication (Mean±SD)	DM without complication (Mean±SD)	*P-value*
Copper level (Mg/L)	0.196±0.049	0.162±0.066	0.012
Magnesium level (Mg/L)	14.04±2.61	15.77±3.27	0.011
Hb A1C (%)	8.48±2.29	7.56±1.61	0.041

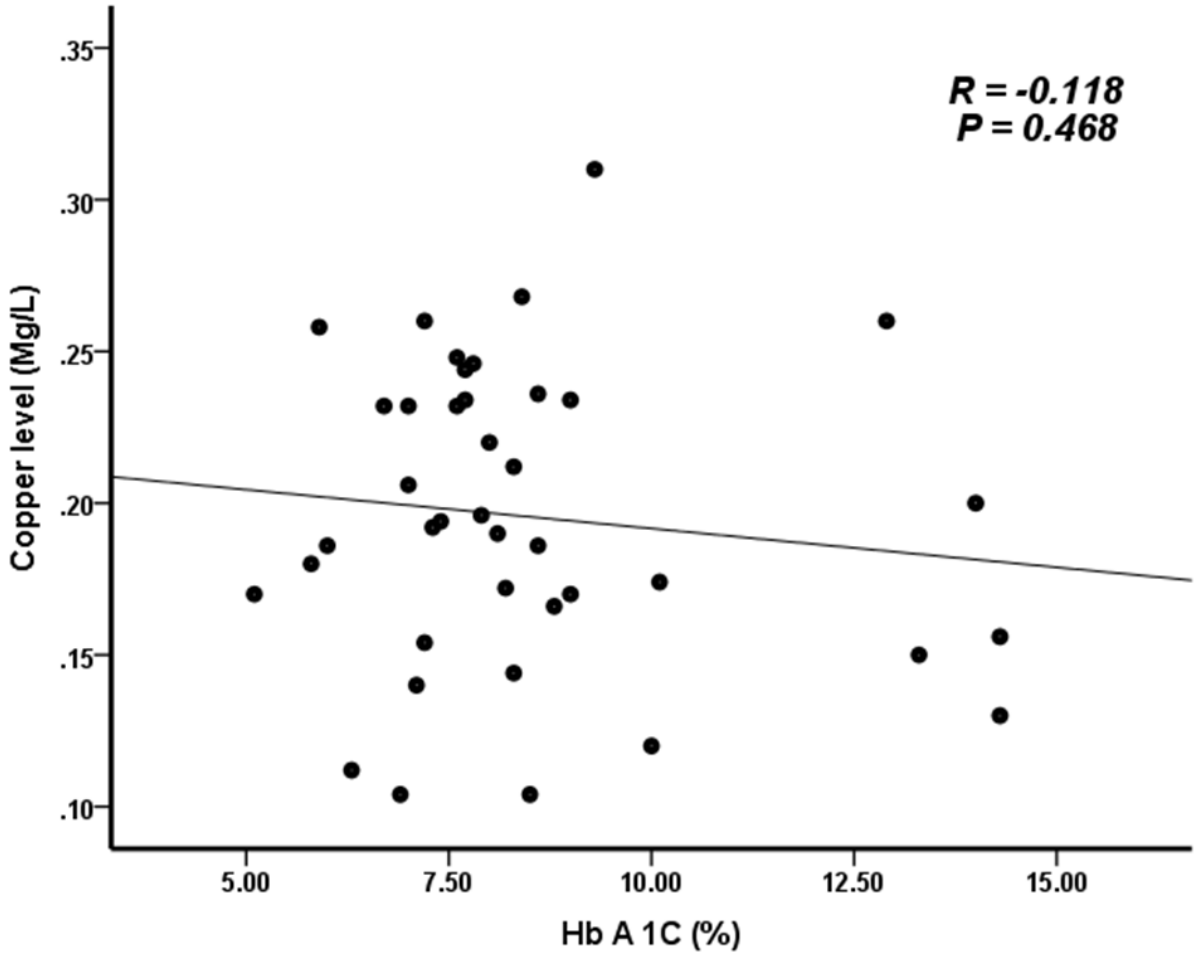

Figure 1. Correlation between HbA1c and Copper (mg/L) level in diabetic patient. Significant consider as *p-value* ≤ 0.05.

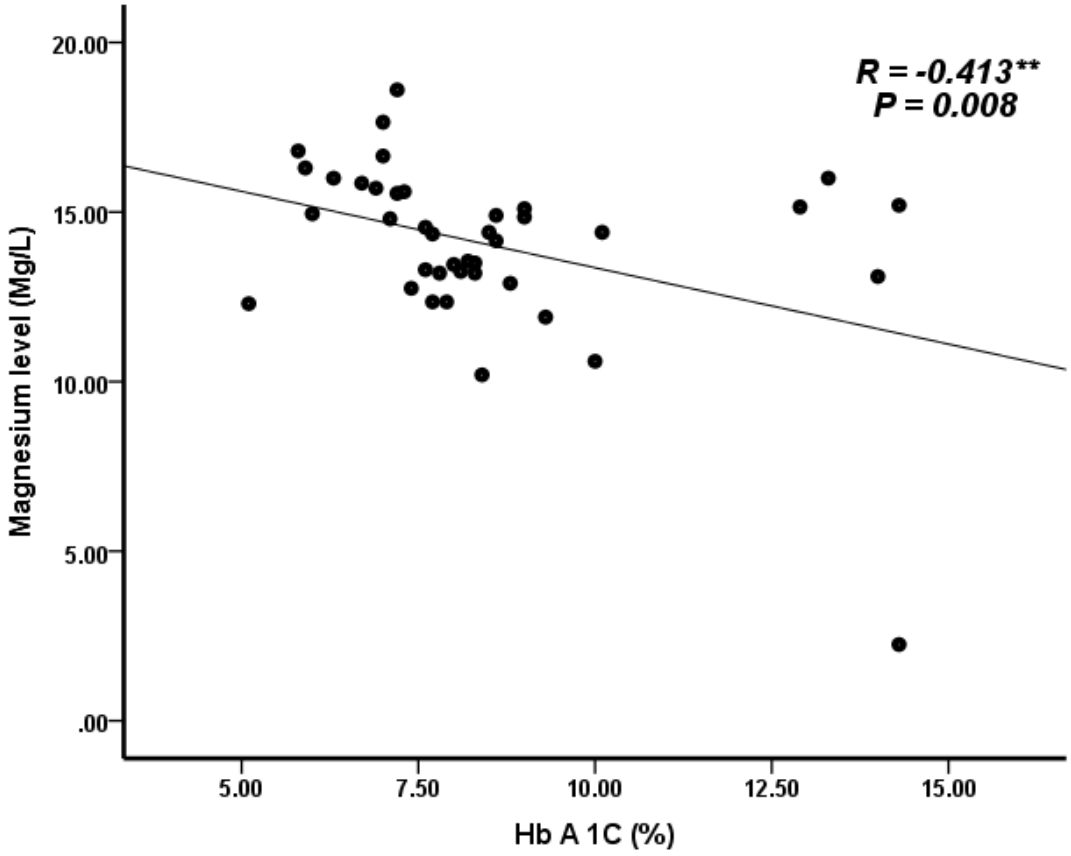

Figure 2. Correlation between HbA1c and Magnesium (mg/L) level in diabetic patient. Significant consider as *p-value* ≤ 0.05

In our study we found that diabetics with micro vascular complications had significantly lower level of serum magnesium (14.04±2.61) compared to diabetics without micro vascular complications (15.77±3.27) *p-value* 0.011 Which presented in table 2. Also the results show significant difference increase in mean concentration of HbA1c in diabetic patient type 2 with complication (8.48±2.29) in comparison with diabetic patient type 2 without complication (7.56±1.61) with *p–value*. 0.041 Which presented in figure 2. Thus hypomagnesaemia may be a possible risk factor in development and progress of diabetic complications. The precise mechanism for development of micro vascular changes is not fully understood, it is possible that hypomagnesaemia inhibits prostacyclin receptor function producing an imbalance between prostacyclin and thromboxane effect which has marked atherogenic potential which is responsible for micro vascular complications Baig *et al.,* 2012.

Many research studies had showed similar findings in magnesium level among diabetic patient type 2 with and without complication % (Ramachandra *et al.,* 2013, Khalil *et al.,* 2016 and Puri *et al.,* 2013). In our study, mean copper was significantly increased among diabetic patient type 2 with complication (0.196±0.049) in comparison with (0.162±0.066) diabetic patient type 2 without complication *p-value* 0.012. Similar finding has been observed by other studies as Devi *et al.,* 2016, Di-Silvestro *et al.,* 2000. Previous studies have shown that copper causes oxidative stress. Copper acts as a pro oxidant and may participate in metal catalyzed formation of free radicals. The increased production of free radicals is likely to be associated with development of type 2 DM. In our study Person's correlation showed, there is no correlation between serum copper level and HbA1c (r = -0.118, p-value 0.468) which presented in figure 1. In another study, a negative correlation between, (Evliyaoğlu, 2004) that difference may be attributed sample size or population .

Also correlation showed, serum magnesium level is inversely correlated with HbA1c (r = -0.413**, p-value 0.008) which presented in figure 2, all these observations

suggest that serum magnesium and copper estimation should be a part of the screening panel in the risk detection and progression of diabetic complications. Many research studies had showed similar findings in magnesium level and inversely correlated with HbA1c % (Ramachandra *et al.,* 2013, Khalil *et al.,* 2016 and Puri *et al.,* in 2013).

CONCLUSION

Type 2 diabetic patients with amputation have lower levels of serum magnesium and higher levels of copper compared to patients without amputation, there is no correlation observed between glycemic control and serum levels of copper.

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