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Research Article

CORRELATION OF OXIDATIVE STRESS MARKERS MALONDIALDEHYDE (MDA), ANTIOXIDANT VITAMINS A, E, AND C WITH GLYCATED HEMOGLOBIN (HBA1C) LEVELS IN TYPE 2 DIABETES MELLITUS

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ABSTRACT

Objective: The purpose of this study was to understand the relationship between oxidative stress markers malondialdehyde (MDA), antioxidant Vitamins A, E, and C and the glycated hemoglobin levels with Type 2 diabetes mellitus.

Methods: The current study is a cross-sectional study group, comprised no diabetic individuals (100 healthy) as control groups and diabetic patients (300) as cases groups, attending the Khartoum - Sudan for routine follow-up during 2013–2015. The data were collected with the help of structured questionnaire and direct interview to collect information. Blood specimens were collected from both groups, and plasma levels of MDA, serum zinc, antioxidant Vitamins (A, E, and C), and glycated hemoglobin (HbA1c) were determined. Odds ratio and the 95% confidence interval (95% CI) were calculated for the presence of mutation between cases and controls and analyzed by SPSS program, version 13.

Results: The results of this study indicate a highly significant difference between the means of HbA1c% of the test group (n=300) and the control group (n=100). Mean ± SD: 7.5 ± 1.4 versus 4.9 ± 0.3, respectively (p=0.001). Significant positive correlation between HbA1c and MDA (p=0.003). Significant correlation between HbA1c% and plasma Vitamins A, E, and C of the test group, respectively (p=0.002), (p=0.0008), and (p=0.01).

Conclusion: There was significant correlation between HbA1c% with Malondialdehyde (MDA) and antioxidant Vitamins (A, C, and E).

Keywords: Type 2 diabetes mellitus, Glycated hemoglobin, Malondialdehyde, Antioxidant vitamins.

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INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder associated with many complications includes hyperglycemia, oxidative stress, and inflammation [1]. There are two types of DM called Types 1 and 2. The most frequent one is Type 2 DM (T2DM), which is a disease that characterized by high levels of blood glucose. The prevalence of Type 2 diabetes is increasing health burden in both developed and underdeveloped countries [2]. Stress is recognized as one of the risk factors that cause the development of Type 2 diabetes. During the development of the disease, hyperglycemia causes increase the production of free radicals, especially reactive oxygen species, for all tissues from glucose autoxidation and protein glycosylation [3]. Antioxidant defense mechanisms include both enzymatic and non-enzymatic strategies. The most common antioxidants include the Vitamins A, C, E, and the tripeptide glutathione, and the enzymes superoxide dismutase, malondialdehyde (MDA), catalase, glutathione peroxidase, and glutathione reeducates [4]. Glycated Hb level is a useful tool used in diagnosis of diabetes progression. Elevated glycosylated hemoglobin (HbA1c) in the blood is an indicator of chronically raised blood glucose concentrations that are used as a method of identifying people at risk of developing diabetes or as a marker of poor control in diagnosed diabetics [5]. Glycated hemoglobin causes an increase of highly reactive free radicals inside blood cells. This leads to blood cell aggregation and increased blood viscosity which results in impaired blood flow [6]. There is the significant correlation between blood glucose and HbA1c values [7]. Hence, the aim of the current study was to correlate glycated hemoglobin with MDA, antioxidant Vitamins A, E, and C in Type 2 diabetes.

METHODS

A total of 100 healthy subjects were control group with mean fasting blood sugar (FBS) 5.61= m mol/L. The age ranged from 22 to 78 years old. The mean age average was 50.1 years. Type 2 diabetic patients were 300; the ages ranged from 30 to 80 years old. The mean age average was 51.2 years. All samples were in a state of fasting for 12 h before drawing blood. This study was conducted in Khartoum state in advanced diagnostic center in Bahri from May 2013 to August 2015. HbA1c percentage level was determined by method based on boronate affinity chromatography using NYCOCARD READER II – AXIS-SHIELD PoC AS NO-0504 Oslo, Norway, rapid *in vitro* test for the measurement of glycated hemoglobin (HbA1c) % in human whole blood. The machine (NYCOCARD READER II) is traceable to the International Federation of Clinical Chemistry reference method for the measurement of HbA1c, and its measuring range 3–18% HbA1c [8]. MDA serum was mixed with 20% TCA and allowed to stand for 10 min. After that, 0.05m H2So4 and TBA were added. The mixture was mixed and placed in 70°C water bath for 30 min. The resulting chromogen was extracted with n-butanol and centrifuged at 2000 rpm/min and measured against butanol blank at 532 nm excitation and 553 nm emissions by spectrophotometer [9]. Vitamins A, E, and C antioxidant were assayed by chromatography measurements were made using Hewlett-Packard (Wald born, Germany) model 1050 pump system, Water 717 plus Auto Sampler (Mil Ford, MA, USA), SPD-10 AV VP (Shimadzu Kyoto, Japan), and an HP-3365 series II Chemstation. The body mass index is a statistic developed by Adolphe Quetelet in the 1900s for evaluating body mass by bodyweight in kilograms divided by height in meters squared.

Statistical analysis

Statistical Package for the Social Sciences SPSS (version 13) computer software was used for data analysis. The means and standard deviations of variable calculated and t-test was used for comparison (significant level was set at p≤0.05).

RESULTS

The results of this study indicate a highly significant difference between the means of HbA1c% of the test group and their FBS Fig. 1. Fig. 2 shows significant moderate positive correlation between HbA1c and plasma MDA of the test group (p=0.003). Fig. 3 shows significant a strong negative correlation between HbA1c% and plasma Vitamin A of the test group (p=0.002). Fig. 4 shows significantly strong negative correlation between HbA1c and plasma Vitamin C of the test group (p=0.01). Fig. 5 shows significantly strong negative correlation between HbA1c and plasma Vitamin E of the test group (p=0.0008).

DISCUSSION

The results of our study show a highly significant difference between the means of HbA1c% of the test group and the control group, this finding is similar to several previous studies recommend using of HbA1c as a potential biomarker for predicting dyslipidemia in Type 2 diabetic patients in addition to glycemic control [10-13]. In the present study, we found positive correlation between glycated hemoglobin and MDA, this results are consistent with the work of Salem *et al.*, stated that, MDA showed statistically significant positive correlation with HbA1c and concluded that trace elements and MDA could have a role as cofactors in the pathogenesis and complications of T2DM [14]. Mawatari *et al.* showed that MDA level was not correlated with the HbA1 [15]. There are many data suggest that MDA as a lipid peroxidation indicator is higher in uncontrolled diabetes probably due to chronic high blood sugar followed by higher oxidative stress [16]. Our study also examined the effect of HbA1c with Vitamin C among T2DM and found there was significant correlation between HbA1c% antioxidant Vitamin C. The result of this study is similar to the findings of the study conducted by Al Azzam *et al.* and concluded that oral supplementation of Vitamin C as an adjuvant with antidiabetic drugs may be of particularly attractive therapeutic effect in the treatment of T2DM [1]. Many studies have shown a decreased Vitamin C level in Type 2 diabetic patients, and this finding supported the relationship between HbA1c percent and antioxidant Vitamin C. Another study by Sridulyakul *et al.* reported that the significant decrease which was noted in the HbA1c in patients supplemented with Vitamin C and concluded that Vitamin C supplementation could reverse diabetes-induced endothelial cell dysfunction in mesenteric microcirculation [17]. We found significant correlation between HbA1c% and plasma Vitamin E. This finding is consistent with many studies and concluded that Vitamin E supplementation was able to improve the already existing oxidative

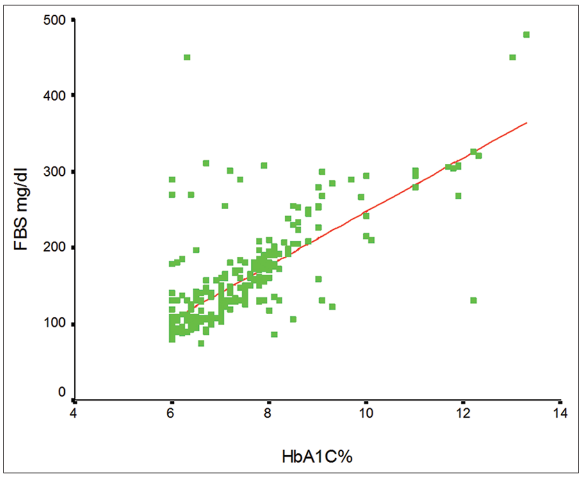

Fig. 1: Scatter plot shows the relationship between HbA1c% and serum fasting blood sugar (FBS) of the test group (n=300) (r=0.74, p=0.0001*). *Significant relationship between the changes in HbA1c% and FBS among the test group (p<0.05)

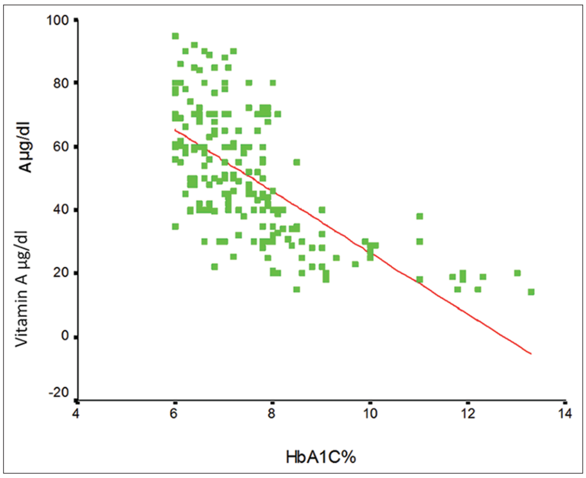

Fig. 3: Scatter plot shows the relationship between HbA1c% and serum Vitamin A of the test group (n=300) (r=0.67, p=0.001*). .*Significant relationship between the changes in HbA1c% and serum Vitamin A among the test group (p<0.05)

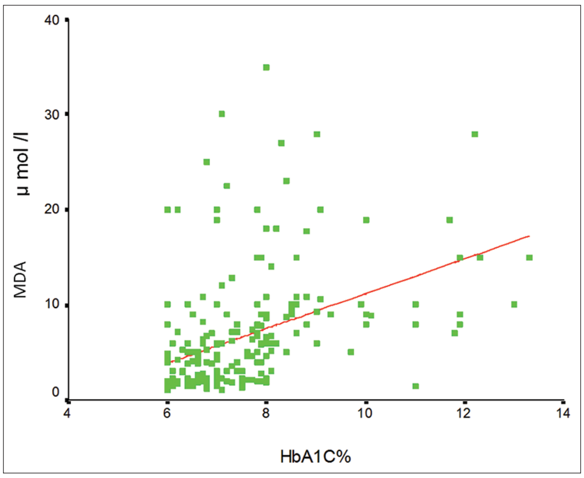

Fig. 2: Scatter plot shows the relationship between HbA1c% and MDA of the test group (n=300) (r=0.41, p=0.01*). .*Significant relationship between the changes in HbA1c% and serum MDA among the test group (p<0.05)

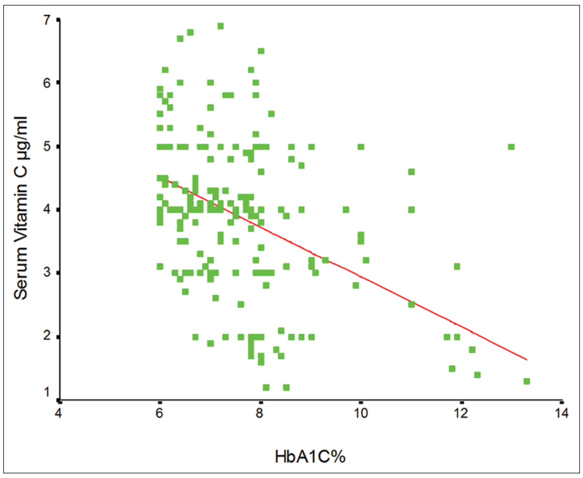

Fig. 4: Scatter plot shows the relationship between HbA1c% and serum Vitamin C of the test group (n=300) (r=0.45, p=0.01*). .*Significant relationship between the changes in HbA1c% and serum Vitamin C among the test group (p<0.05)

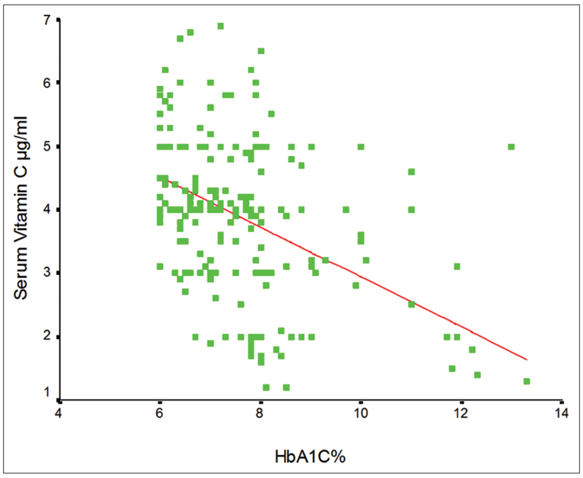

Fig. 5: Scatter plot shows the relationship between HbA1c% and serum Vitamin E of the test group (n=300) (r=0.66, p=0.001*). *Significant relationship between the changes in HbA1c% and serum Vitamin E among the test group (p<0.05)

stress in Type 2 diabetic patients [18,19]. Our result supported by the data from some studies suggests that Vitamin E supplements may lower HbA1c levels in patients with inadequate glycemic control [20]. We found significantly correlation between HbA1c% and plasma Vitamin A. Our finding is consistent with several studies which conducted among Type 2 diabetic patients [21,22]. There is link between diabetes and deficient of Vitamin A levels indicating Vitamin A supplementation may have a role in T2DM biology [23]. In general, antioxidant Vitamins A, C, and E are found decreased in diabetic subjects, possibly due to an increased need to control the excessive oxidative stress produced by abnormalities in glucose metabolism [24]. This alteration in antioxidants vitamins metabolism is related to increased values of glycated hemoglobin. Our study has many limitations: These include the relatively small sample size, potential markers such as levels of reduced glutathione (GSH), copper, magnesium, and Vitamin D.

CONCLUSION

The present study indicates that the HbA1c levels were found to be correlated positively with plasma levels of MDA, antioxidant Vitamins A, E, and C. According to the finding, we suggest that the estimation of MDA, HbA1c, and antioxidant vitamins could be helped in effective control and prevention among Type 2 diabetes patients.

AUTHOR'S CONTRIBUTION

There is no conflict of interests between authors; all three authors have made substantial contributions to conception and design, analysis, and interpretation of data. All authors have participated in drafting and revising the article and have given their final approval for submission.

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