Original Article

Determination of the serum levels of troponin I and creatinine among Sudanese type 2 diabetes mellitus patients

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Abstract

Background: Diabetes mellitus (DM) is a significant risk factor for developing cardiac diseases. Hence, we compare the serum levels of cardiac troponin I (CTnI) among type 2 diabetic and healthy patients. We additionally correlated CTnI and creatinine levels with duration of disease. **Materials and Methods:** A cross-sectional study was conducted at Department of Clinical Chemistry, Sudan University of Sciences and Technology, Khartoum, Sudan, from February 2008 to February 2011. 200 patients diagnosed with DM type 2 from Jabir Abulizz Diabetes Centre in Khartoum state, Sudan, and 100 healthy volunteers were included in this study. Blood samples were collected from both groups, and the serum levels of CTnI, creatinine, fasting plasma glucose and glycosylated hemoglobin (HbA1c) levels were measured. **Results:** Significant increase in serum levels of CTnI, glucose, HbA1c, and creatinine was observed in diabetic patients compared to healthy controls. In addition, the significant increase in CTnI and creatinine levels was observed among diabetic patients with ischemic heart disease or hypertension when compared with those without ischemic heart disease or hypertension. Further a strong positive correlation was observed between the duration of diabetes and the serum levels of CTnI and creatinine (r = 0.84, P > 0.01) and (r = 0.72, P > 0.01), respectively. **Conclusion:** The higher levels of CTnI and creatinine may be indicative of progressive cardiovascular disease and nephropathy among diabetic patients.

Key words: Cardiovascular diseases, creatinine, diabetics nephropathy, HbA1c

INTRODUCTION

Type 2 diabetes is present in 10-30% of patients presenting with myocardial infarction (MI) and given the expected doubling in the incidence of diabetes over the next 25 years, represents a major public health concern. Hence, early MI risk prediction provides an opportunity for appropriate intensive management.[1] Raised cardiac troponin I and T (cTnI and cTnT) concentrations are now accepted as the standard biochemical marker for the diagnosis of MI.[1] While the HbA1c level is important not only for monitoring of diabetes, but also for assessment of the risk of coronary heart disease in diabetic patients.[2]

Access this article online	
Quick Response Code:	Website: www.jnsbm.org
	DOI: 10.4103/0976-9668.166092

How to cite this article: Karar T, Elfaki EM, Qureshi S. Determination of the serum levels of troponin I and creatinine among Sudanese type 2 diabetes mellitus patients. J Nat Sc Biol Med 2015;6:S80-4.

Diabetics kidney disease or diabetics nephropathy, affects 20-30% of patients with diabetes and it is also one of the most common cause of end-stage kidney disease, which account for a large proportion of patients beginning dialysis therapy.[3,4] Patients with diabetic nephropathy have abnormal serum creatinine levels.[5]

The above biomarkers may be used to develop patient demographics, which may be useful in developing health policies. Hence in this study, we aimed to evaluate serum cTnI as cardiac muscle marker for detection of early cardiovascular disorder among Sudanese type 2 diabetic patient. Further, we assessed renal function among diabetic patient by measuring serum creatinine levels. We also assessed the glycemic control by measuring HbA1c levels.

MATERIALS AND METHODS

Study approach, design, population, and area

A cross-sectional study was conducted at Sudan, Khartoum state, Sudan University of Science and Technology, College of Medical Laboratory Sciences from February 2008 to February 2011 to evaluate the serum levels of CTnI and creatinine in Sudanese patients with type 2 DM. The study population consisted of 300 male and female subjects divided into two groups, 200 subjects diagnosed with type 2 DM were enrolled in this study, and they regularly visit Jabir Abulizz diabetes center for routine follow-up. Totally 100 healthy volunteers (age- and sex-matched) were included as control group.

Inclusion criteria

- Test group: Sudanese patients with type 2 DM with no evidence of coronary artery disease or impaired cardiac function.
- Control group: Healthy subjects.

Exclusion criteria

Patients with type 1 DM, female with gestational diabetes, type 2 DM patients with cardiac diseases and those with thyroid disease were excluded from this study.

Ethical consideration

The Ethics Committee of Sudan University approved the study. Written informed consents were obtained, all participants were informed of the study aims and health education was also provided to all participants.

Data and sample collection

An interview with a questionnaire was used to obtain the clinical data from each participant in this study. A physician took clinical history and performed an examination of the test and control group. Venous blood (6 mL) sample was equally divided into three containers, that is, 2 mL in fluoride oxalate anticoagulant container for plasma glucose, and 2 mL in EDTA container for HbA1c (whole blood) and the last one placed in plain container and after clotting centrifuged at 3000 rpm for 3 min to obtain serum for troponin I and creatinine estimation. Serum or plasma were separated into a plain container and kept at −20°C until used.

Analytical procedure

Measurement of serum cardiac troponin I

cTnI (ng/mL) was measured using the particle enhanced fluorescence immunoassay technique (i-CHROMA™ analyzer).

Estimation of glycated hemoglobin

After preparing the hemolysate, where the labile fraction is eliminated, hemoglobin is retained by a cationic exchange resin (HbA1c) which is specifically eluted after washing away the hemoglobin A_{1a+b} fraction (HbA_{1a+b}) and is quantified by direct photometric reading at 415 nm.

Measurement of plasma glucose

Glucose catalyzed by glucose oxidase yield H_2O_2 which oxidized to yield a color dye of quinonimine. The absorbance increase is directly proportional to the concentration of glucose.

Measurement of serum creatinine

Creatinine reacts with picric acid under the alkaline condition to form a yellow-red complex. The absorbance of the color produced is measured at a wavelength 492 nm, which is directly proportional to creatinine concentration in the sample.

Statistical analysis

Data from all patients are presented as percentage and (mean ± standard deviation). Differences between means of patients and control groups were considered statistically significant with P value threshold <0.05 using the independent t-test. A significant correlation (r) was calculated using Pearson correlation test.

RESULTS

The test group was composed of 112 males (56%) and 88 females (44%), whereas the control group was composed of 59 males (59%), and 41 females (41%). 33.5% ($n = 67$) of patients were hypertensive, 14% ($n = 28$) and renal insufficiency, 7% ($n = 14$) had gout and 11% ($n = 22$) had liver disease. 35% ($n = 70$) of patients were described as obese based on body mass index calculation [Tables 1-5 and Figures 1-5].

Table 1: Demographic characteristics of study population (diabetic patients with and control subjects)

Parameter	Diabetic patients	Control subjects
Number of subject	200	100
Sex (male number)	112	59
Sex (female number)	88	41
Age (years)	60.72±9.18	59.75±12.36
Weight (kg)	74.30±14.85	69.89±14.33
Height (cm)	164.86±13.18	162.20±14.50
BMI (kg/m^2)	28.92±5.29	25.86±4.91

BMI: Body mass index

Table 2: Comparison of means of serum levels of CTnI and creatinine of the test group and the control group

P	Control group (*n* = 100)	Test group (*n* = 200)	*P*
CTnI (ng/mL)	0.15±0.04 (0.10-0.21)	0.12±0.01 (0.10-0.14)	0.014
Creatinine (mg/dL)	1.07±0.29 (0.6-1.5)	0.77±0.14 (0.5-1.0)	0.032

Mean ± SD, CI and probability, CTnI: Cardiac troponin I, SD: Standard deviation, CI: Confidence interval

Table 3: Comparison of means of serum levels of CTnI and creatinine of the diabetic patients with ischemic heart disease and those without ischemic heart disease

Variable	Patients with ischemic heart disease (*n* = 28)	Patients without ischemic heart disease (*n* = 172)	*P*
CTnI (ng/mL)	0.19±0.01	0.15±0.04	0.007
Creatinine (mg/dL)	1.42±0.13	1.010±0.27	0.025

Mean ± SD and probability. CTnI: Cardiac troponin I, SD: Standard deviation

Table 4: Comparison of means of serum levels of CTnI and creatinine of the diabetic patients with hypertension with those without hypertension

Variable	Patients with hypertension (*n* = 67)	Patients without hypertension (*n* = 133)	*P*
CTnI (ng/mL)	0.19±0.01	0.13±0.03	0.004
Creatinine (mg/dL)	1.42±0.08	0.89±0.19	0.0001

Mean±SD and probability, CTnI: Cardiac troponin I, SD: Standard deviation

Table 5: Comparison of means of serum levels of CTnI and creatinine of the diabetic patients with liver disease with those without liver disease

Variable	Patients with liver disease (*n* = 22)	Patients without liver disease (*n* = 178)	*P*
CTnI (ng/mL)	0.20±0.000	0.15±0.04	0.0001
Creatinine (mg/dL)	1.45±0.07	1.00±0.29	0.0001

Mean±SD and probability, CTnI: Cardiac troponin I, SD: Standard deviation

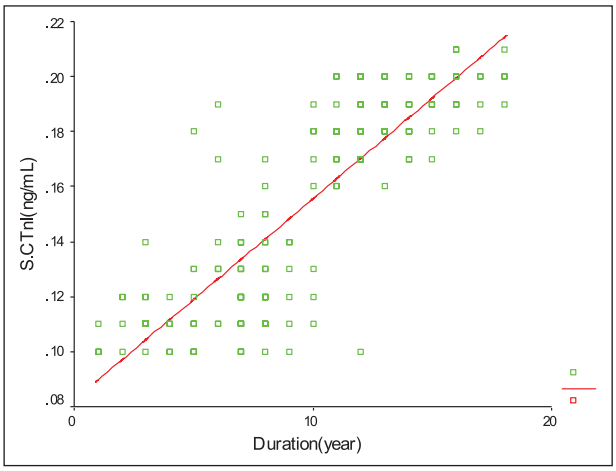

Figure 1: A scatter plot shows the relationship between the duration of diabetes (year) and the serum levels of cardiac troponin I (ng/mL) (**r** = 0.84, **P** > 0.01)

DISCUSSION

Diabetes mellitus is commonly associated with both microvascular and macrovascular complications, and specifically type 2 DM contributes to subclinical myocardial injury. Type 2 DM is also associated with increased arterial stiffness consequence to increased oxidative stress accelerated endothelial cell apoptosis, endothelial dysfunction, and depletion of endothelial progenitor cells all of which may predispose to increased cardiovascular risk.[6] Early prediction of this risk will be very valuable in the clinical management of the disease. Hence, several studies have focused on the prediction of cardiovascular diseases among diabetic patients.[7-10]

The cTnT and cTnI are extremely sensitive and considered as specific biomarkers of myocardial necrosis and crucial biomarkers for the diagnosis of MI.[11-13]

We observed a significant (P = 0.014) increase in CTnI among diabetic patients when compared with the nondiabetic group. Hence indicating that CTnI estimation may be a valuable biomarker to assess or predict progression of adverse cardiovascular events in Sudanese patients with type 2 DM. Further hypertensive diabetic patients are at much higher risk of developing cardiac pathology.[14] Consistent with this, in our study CTnI levels were significantly (P = 0.004) higher among diabetic hypertensive patients compared to normotensive diabetic patients. This may be indicative of synergistic effects of hypertension and diabetes on myocardial damage.[15,16]

In addition, creatinine level was significantly (P = 0.032) higher among diabetic patients compared to nondiabetic patients. Such impairment of renal function among diabetic patients may be due to hyperglycemia-induced

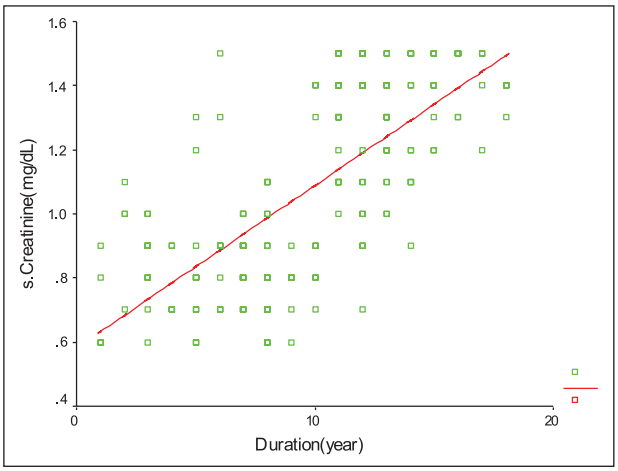

Figure 2: A scatter plot shows the relationship between the duration of diabetes (year) and the serum levels of creatinine (mg/dL) (**r** = 0.72, **P** > 0.01)

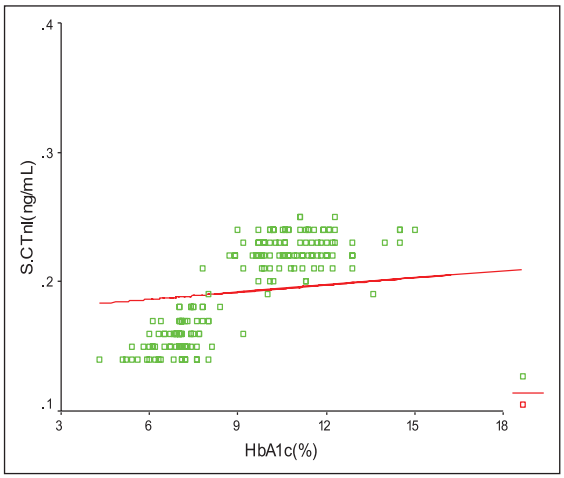

Figure 3: A scatter plot shows the relationship between HbA1c (%) and the serum levels of cardiac troponin I (ng/mL) (**r** = 0.34, **P** < 0.05)

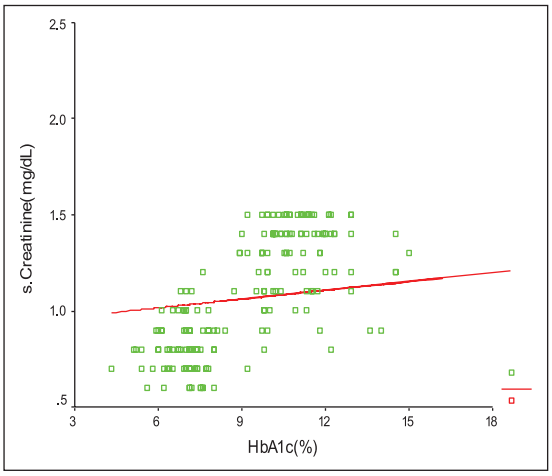

Figure 4: A scatter plot shows the relationship between HbA1c (%) and the serum levels of creatinine (mg/dL) (**r** = 0.35, **P** < 0.05)

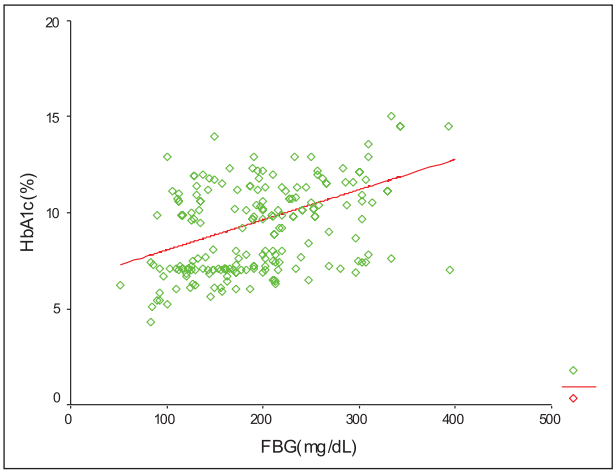

Figure 5: A scatter plot shows the relationship between the fasting plasma glucose (mg/dL) and HbA1c (%) (**r** = 0.72, **P** > 0.01)

hemo-concentration effecting the renal filtering physiology eventually leading to systemic accumulation of waste products,[16] and nephropathy.

The creatinine level was further higher among hypertensive diabetic patients, which may be influenced by antihypertensive medications.[17] Nevertheless, the correlation of elevated CTnI and creatinine levels with duration and co-existence of cardiovascular and hepatic pathology among diabetic patients may be a reflection of progressive cardiovascular-renal damage among diabetic patients. Hence, we conclude that regular monitoring for CTnI and creatinine levels among Sudanese diabetic patients may be a valuable biomarker for identifying the patients with risk of developing future cardiovascular and/or renal diseases.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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