Original Article

A CROSS SECTIONAL STUDY TO ASSESS TRIGLYCERIDE GLUCOSE INDEX AND TRIGLYCERIDE/HDL RATIO AS POTENTIAL INDICATORS OF GLYCEMIC CONTROL IN TYPE 2 DIABETES MELLITUS

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Abstract

Introduction: The treatment strategy for management of Diabetes Mellitus includes regular monitoring of blood sugars and HbA1C since poor glycemic control is associated with complications causing significant morbidity and mortality.

Aim: To assess the correlation of Triglyceride glucose Index and Triglyceride/HDL ratio with HbA1C to evaluate their possible role as indicators of glycemic control in Type 2 Diabetes Mellitus.

Objectives: To correlate Triglyceride glucose index and HbA1C in patients with Type 2 Diabetes Mellitus.

To correlate triglyceride/HDL-C ratio and HbA1C in patients with Type 2 Diabetes Mellitus.

To evaluate the role of triglyceride glucose index and Triglyceride/HDL-C ratio as potential indicators of glycemic control.

Materials and Methods: A retrospective cross-sectional study was carried out in our Institution among 278 patients with Type 2 Diabetes Mellitus. The necessary biochemical parameters along with history of comorbidities will be noted. The Triglyceride glucose index and Triglyceride/HDL ratio was calculated, and statistical analysis was carried out to correlate the calculated values and HbA1c.

Results: Triglyceride glucose index and Triglyceride/HDL ratio were found to be significantly associated with HbA1c levels in patients with type 2 diabetes mellitus (Pearson correlation coefficient of 0.475 and 0.276 respectively). Triglyceride glucose index is significantly associated with glycemic control (t value -3.627) while Triglyceride/HDL ratio did not show significant association (t value -1.556).

Conclusion: In patients with Type 2 Diabetes mellitus the Triglyceride glucose index is significantly associated with glycosylated hemoglobin (HbA1c) levels and is a potential predictor glycemic control. Triglyceride/HDL ratio is significantly associated with HbA1c levels but failed to show significant association with glycemic control.

Keywords: Type 2 Diabetes Mellitus, HbA1C, Triglyceride Glucose Index, Triglyceride/HDL Ratio.

INTRODUCTION

Diabetes Mellitus is a global disease with prevalence rates increasing over the past few decades. The latest data from the Global Burden of Disease 2019 has established that the Disability Adjusted life Years due to non-communicable diseases (NCDs) has increased significantly over the past three decades in both developed and developing nations. In India the data has established that around 2.73% of the total DALYs are due to Diabetes Mellitus and especially in South India the average rate of the DALYs is 1403.21 per 100000.(1) The major parameter used for the diagnosis and monitoring of Diabetes Mellitus are Fasting Blood Glucose or Fasting Plasma Glucose (FPG), Post Prandial Blood Glucose and Glycosylated Hemoglobin (HbA1c).(2) among them HbA1c is considered gold standard for monitoring the glycemic control for the patients and generally HbA1C values of less than 7% is the target of adequate glycemic control.(3) Diabetes Mellitus also predisposes to other complications especially Atherosclerotic Cardiovascular diseases. Around twenty percentage of all cardiac deaths can be attributed to Diabetes Mellitus. Diabetes Mellitus predisposes to dyslipidemia characterized by elevated triglyceride and low-density lipoprotein and decreased high density lipoprotein. Triglyceride glucose index has been evaluated as a marker of insulin resistance and Triglyceride to HDL ratio which has been considered as atherogenic index of plasma has also been proposed as an indicator of glycemic control.(4,5) Studies has been done to establish association between Triglyceride glucose index and Triglyceride to HDL ratio and insulin resistance and also to atherosclerotic cardiovascular diseases but very few have been done to evaluate the association between these values with glycosylated hemoglobin (HbA1c) values which is the current standard investigation for evaluation of glycemic control along with fasting blood glucose.

AIM

To assess the correlation between Triglyceride glucose index (TyG I) and Triglyceride to HDL ratio with Glycosylated Hemoglobin (HbA1c) values and to explore if these values can serve as potential indicators of glycemic control.

MATERIALS AND METHODS

We conducted a retrospective cross-sectional study in Chettinad Hospital and Research Institute. The study was approved by the Institutional Human ethics Committee of Chettinad Hospital and Research Institute. We selected patients being treated for type 2 Diabetes Mellitus from our electronic data and recorded the necessary information including age, gender, comorbid conditions, and biochemical parameters during their consultation or admission between the months of January 2022 and December 2022. The parameters of interest were individual patient's HbA1c value, fasting plasma blood glucose levels, fasting lipid profile including the Total cholesterol, High Density Lipoprotein Cholesterol, and triglyceride levels. (The Fasting plasma glucose levels and fasting lipid profile are evaluated in samples collected after an overnight fasting). The patients were divided based on their HbA1C into adequate control as HbA1C < 7 and inadequate control as HbA1C > 7.

After recording the necessary variables, the Triglyceride glucose index was calculated using the formula: Ln [TG (mg/dL) x FG (mg/dL)/2]. Triglyceride to HDL-C ratio is calculated by dividing the Triglyceride level (mg/dL) by HDL-C values (mg/dL).

STATISTICAL ANALYSIS

Statistical analysis All statistical analyses were performed using the SPSS statistical package for Windows (version 26.0, SPSS Inc, Chicago, Illinois, USA). Kolmogorov–Smirnov test was used in order to test the normality of distribution of variables. The differences between groups were analyzed by independent t-test where appropriate. Univariate correlation coefficients were determined by Pearson analysis.

RESULTS

In total 278 subjects were included in the study. The average age of the patients was 58.33 years with a minimum age of 29 years and a maximum age of 88 years. Of the total included subjects 59.71% (n=166) were men and 40.28% (n=112) were women.

The total subjects were divided into two groups based on the HbA1C values, 128 subjects had HbA1C less than 7% and were included in the adequate glycemic control group and 150 subjects had HbA1C more than or equal to 7% and were included in the inadequate glycemic control group. The mean age of the subjects in the two groups were similar. The distribution of gender among the two groups were similar with men constituting 60.2% (n=77) and women constituting 39.8% (n=51) in the adequate glycemic control group while in the inadequate glycemic control group 59.3% (n=89) were men and 40.7% (n=61) were women.

Table 1: Descriptive statistics

Parameters	Mean ± Std. Deviation (Range)
FBS	131.12 ± 65.666 (72-428)
HbA1C	7.85 ± 2.001 (5-15)
HDL	51.22 ± 11.464 (11-96)
TGL	149.51 ± 73.149 (35-470)
TyGI	4.84 ±.2909 (3.99-5.73)
Tyg/HDL	3.12 ± 1.9471 (.66-18.27)

The average Fasting Blood Sugars was significantly higher in the inadequate glycemic control group than the adequate glycemic control group 150.31 mg/dl vs 108.62 mg/dl. The mean HbA1C value in the adequate glycemic control group was 6.33% and the mean HbA1C value of in the inadequate glycemic control group was 8.86%. The triglyceride and High-Density Lipoprotein levels were similar in both the groups refer Table 3.

Table 2: Correlations of TyGI and Tyg/HDL ratio. (Pearson)

	FBS	HbA1C	HDL	TGL	TyGI	Tyg/HDL
TyGI	.619**	.475**	-.135*	.708**	1	.631**
Tyg/HDL	.056	.246**	-.466**	.786**	.631**	1
*. Correlation is significant at the 0.05 level (2-tailed).						
**. Correlation is significant at the 0.01 level (2-tailed).						

The mean Triglyceride glucose index of the total subjects was 4.84. The mean Triglyceride glucose index in subjects with adequate glycemic control was 4.77 and in subjects with inadequate glycemic control it was 4.90. Univariate correlation analysis between Triglyceride glucose index and other parameters revealed significant correlations with FBS, HbA1c, TGL, Tyg/HDL ratio and negative correlation with HDL.

The mean Triglyceride to HDL-C ratio of the total subjects was 3.12. The mean Triglyceride to HDL-C ratio was 2.92 in subjects with adequate glycemic control while the ratio was 3.28 in patients with inadequate glycemic

control. Univariate correlation analysis of Triglyceride to HDL-C ratio revealed significant correlations with HbA1c, TGL and TyG index, negative correlation with HDL levels and no correlation with FBS.

In our study, the triglyceride glucose index was found to be significantly associated with the HbA1C levels in patients with type 2 Diabetes Mellitus and based on independent samples t-test analysis done showed significant correlation to adequacy of glycemic control when subjects were grouped based on the HbA1c values.

Table 3: Independent sample t test

	HbA1C	Mean	Std. Deviation	t *sig
FBS	Adequate glycemic control	108.62	41.031	-5.554**
	Inadequate glycemic control	150.31	75.996	
HDL	Adequate glycemic control	52.74	9.892	2.058*
	Inadequate glycemic control	49.92	12.539	
TGL	Adequate glycemic control	150.40	73.609	.186^{NS}
	Inadequate glycemic control	148.76	72.993	
TyGI	Adequate glycemic control	4.77	.2531	-3.627**
	Inadequate glycemic control	4.90	.3091	
Tyg/HDL	Adequate glycemic control	2.92	1.5038	-1.556^{NS}
	Inadequate glycemic control	3.28	2.2493	

The Triglyceride to High Density lipoprotein ratio was also found to be significantly associated with HbA1c levels in patients with type 2 diabetes mellitus but on analysis with independent samples t test, the Tgl/HDL ratio was not found to be significantly associated with adequacy of glycemic control when subjects were grouped based on the HbA1c values.

Figure 1: Scatterplot of correlation between HbA1c and triglyceride glucose index

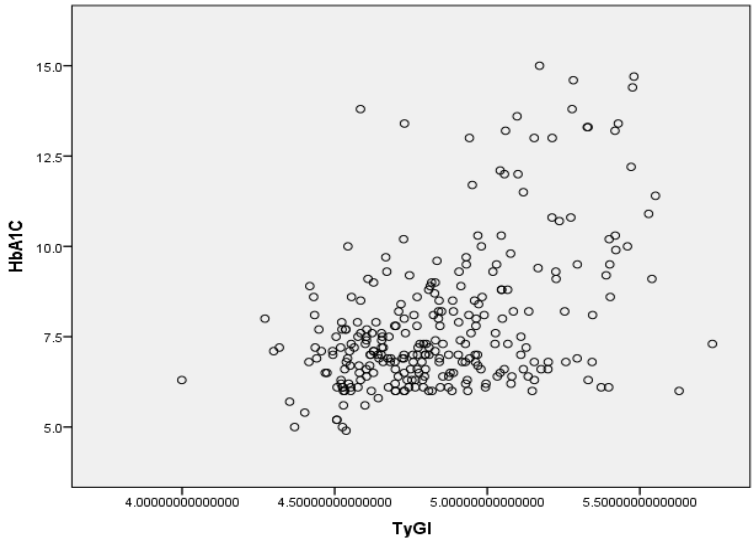
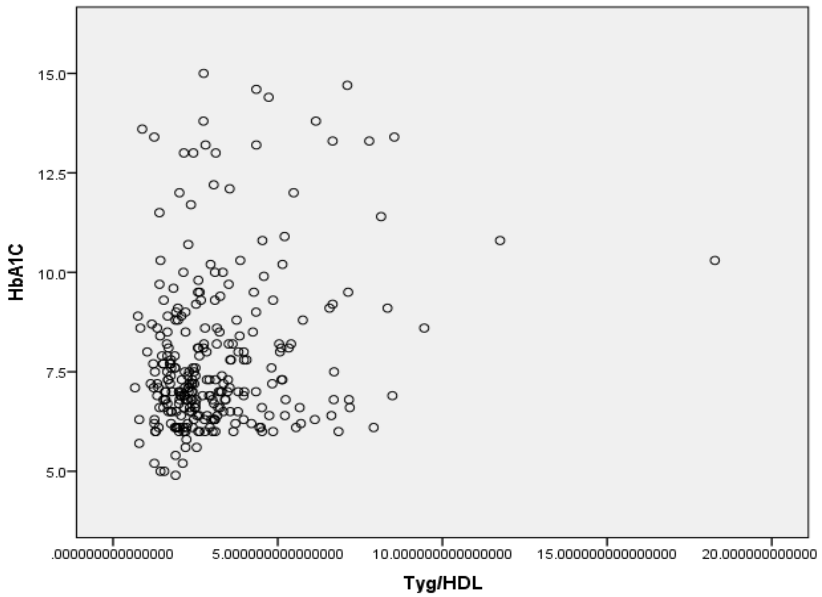


Figure 2: Scatterplot showing correlation between HbA1c and Tyg/HDL-C



DISCUSSION

Inadequate glycemic control in patients with Diabetes Mellitus over a period of time has been associated with macrovascular and microvascular complications.(6,7) The incidence and prevalence of atherosclerotic cardiovascular disease and coronary artery disease is significantly high among patients with type 2 diabetes mellitus. Hyperglycemia has been substantially linked to the frequency of clinical consequences. Every 1% drop in the revised mean HbA1c was linked to a risk reduction of 21% for any diabetes-related end point, 21% for diabetes-related mortality, 14% for myocardial infarction, and 37% for microvascular sequelae.(8)

Patients with insulin resistance due to type 2 diabetes mellitus by itself or as part of metabolic syndrome are associated with increased prevalence of dyslipidemia with increased levels of total cholesterol, low density lipoprotein cholesterol, triglycerides and low levels of High Density lipoprotein Cholesterol.(9–13) High levels of serum triglycerides and low levels of HDL-C generally called as atherogenic dyslipidemia has been associated with diabetes mellitus. (14,15).

Triglyceride glucose index calculated using the formula Ln [TG (mg/dL) x FG (mg/dL)/2] has been assessed and proven to be a potential marker of insulin resistance.(16–20). The triglyceride glucose index as a marker of insulin resistance has been positively associated with macrovascular complications such as coronary artery disease in various studies.(4,18,21–24) Babic et al found that triglyceride glucose index was positively associated with glycemic control in patients with type 2 diabetes with mean value higher in patients with HbA1C more than 7% when compared to patients with HbA1C levels less than 7%.(25)

Our study also showed positive correlation between the triglyceride glucose index and HbA1c levels (Pearson correlation coefficient 0.475). In our study the mean triglyceride glucose index in patients with HbA1C more than or equal to 7% was 4.90 as against the mean triglyceride glucose index in patients with HbA1C less than 7% which was 4.77. Based on Independent samples t test we found significant correlation between Triglyceride glucose Index and adequacy of glycemic control based on HbA1c value (t value -3.627).

Triglyceride to HDL-C ratio has been associated with increased risk of atherosclerotic events such as coronary artery disease by various studies with TGL/HDL-C ratio more than 2 has been increasingly associated with atherosclerotic diseases.(23,26,27) In a study by Yang et al Triglyceride to HDL-C ratio has also been found to be higher in patients with pre-diabetes and type 2 diabetes in patients with coronary heart disease.(28) Triglyceride to HDL-C ratio has been evaluated and found to be as a potential marker for insulin resistance in studies by Gonzalez et at, Selvi et al and Chauhan et al.(5,17,29) Studies have shown positive correlation between Triglyceride to HDL-C ratio and HbA1C and thus a potential marker for glycemic control.(17,30) Babic et al in

their study found that When patients with Type 2 Diabetes Mellitus were divided into groups based on their BMI values, the independent relationship between the TG/HDL-C ratio and HbA1c remained significant only in subjects who were normal weight, while there was no significant relationship between the TG/HDL-C and glycemic control in subjects who were overweight or obese.(25)

Our study showed significant association between the triglyceride to HDL-C ratio and HbA1c in patients with Type 2 Diabetes Mellitus (Pearson correlation coefficient of.246). In our study subjects with inadequate glycemic control has elevated mean Triglyceride to HDL-C ratio when compared to subjects with adequate glycemic control. Subjects with HbA1c less than 7% had a mean Triglyceride to HDL-C ratio of 2.925 while subjects with HbA1C more than or equal to 7% had a mean Triglyceride to HDL-C ratio of 3.288. The mean ratio was more than 2 in both the groups and based on previous studies are at increased risk of acquiring atherosclerotic diseases such as coronary artery disease. Based on Independent samples t test analysis we found no significant correlation between the Triglyceride HDL ratio and adequacy of glycemic control based on the HbA1c values (t value -1.556).

LIMITATIONS OF THE STUDY

Our study was a retrospective cross-sectional study and changes in the values over a period of time and information regarding management of diabetes were not included. Data on diet patterns and lifestyle of the subjects were not known.

The values were not compared against markers of insulin resistance.

Anthropometric measurements especially the Body Mass index which can be a potential confounder was not included in the study.

Future large scale prospective studies can be done based on management of blood glucose and blood cholesterol by various pharmaceutical strategies and their impact on triglyceride glucose index and triglyceride to HDL ratio along with estimation of their impact on various atherosclerotic cardiovascular diseases.

CONCLUSION

In patients with Type 2 Diabetes mellitus the Triglyceride glucose index is significantly associated with glycosylated hemoglobin (HbA1c) levels and is a potential predictor glycemic control. Triglyceride/HDL ratio is significantly associated with HbA1c levels but failed to show significant association with glycemic control.

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