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The Relationship between Triglyceride Glucose Index and Glycemic Control in Type 2 Diabetes Mellitus

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Abstract

Background and Aim: Insulin resistance is the most important step in the pathogenesis of type 2 diabetes. Early diagnosis of insulin resistance is very important in terms of preventing diabetes and diabetes related complications. The HOMA-IR is the method used worldwide in the detection of insulin resistance. With this method, it is necessary to measure the insulin value, which is not routinely used in every laboratory. Triglyceride-Glucose Index (TGI) has recently been used as an alternative measurement method in the detection of insulin resistance. The most important feature of this measurement is that it uses fasting glucose and triglyceride values measured in routine clinical practice, and it is also a practical and inexpensive method. The aim of the present study was to investigate the relationship between TGI and glycemic control in patients with type 2 diabetes mellitus (T2DM).

Material and Methods: We retrospectively studied randomly recruited 100 patients with diabetes mellitus admitted to the Department of Internal Medicine, Faculty of Medicine, Adıyaman University between January 2022 and September 2022. Cases were divided into two groups based on their glycemic control. In general, HbA1c levels below 7% were considered good glycemic control, while levels above 7% were considered poor glycemic control. The TGI for these groups was compared along with other laboratory values. Data on cases' demographics and laboratory results were retrospectively

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obtained from hospital records. Patients age, triglyceride, LDL, HDL, total cholesterole, glucose, ALT, creatinine and HbA1c values were retrospectively recorded. The TGI index was calculated using the following equation: Fasting logarithm (ln) [fasting triglycerides (TG, mg/dL)/2 + fasting blood glucose (FBG, mg/dL).

Results: Cases with good glycemic control had a mean TGI of 4.88±0.24, whereas those with poor glycemic control had a mean TGI of 5.17±1.33. When comparing the TGI of both groups, a statistically significant difference was found between them (p-value <0.01). In ROC curve analysis, the optimal cutoff value for poor glucose control was 4.88 with a sensitivity of 47.5% and specificity of 78.3% (AUC=0.24, 95 Cl: 0.15-0.34).

Conclusion: Even though TGI levels were significantly associated with poor glycemic control, optimal cutoff values had low specificity and sensitivity. Therefore, future studies are needed in order to determine the value of TGI in screening for poor glycemic control.

Keywords: triglyceride glucose index, insulin resistance, diabetes mellitus, HbA1c

INTRODUCTION

As a result of insulin resistance, muscle, fat, and liver tissues cannot respond to insulin and use glucose effectively. This results in weight gain and obesity. In this situation, the pancreas secretes an excessive amount of insulin, resulting in impaired insulin secretion and abnormal blood glucose levels. To prevent diabetes and its complications, early diagnosis of insulin resistance is critical. A widely used method for detecting insulin resistance is Homeostatic Model Evaluation (HOMA)-IR. This method requires insulin measurement, which is not routinely performed in all laboratories. An alternative measurement method for detecting insulin resistance is the triglyceride glucose index (TGI). The TGI is a simple, cost-effective, and easily accessible marker of insulin resistance calculated from fasting serum glucose and serum triglyceride measurements. In terms of the TGI value, the threshold for insulin resistance was established as > 4.68 (1). Diabetic patients' glycemic control is determined by their HbA1c level. The HbA1c level is a measure of how well the patient's blood sugar has been controlled over the past two to three months. The higher the level of glycated hemoglobin, the poorer the glycemic control. The goal for most diabetic patients is to maintain an HbA1c level below 7%. An HbA1c value of <7% indicates good glycemic control, while >7% indicates poor glycemic control. In this scientific study, the main objective is to investigate whether there is a significant relationship between TGI, a parameter recently published in the medical literature, and glycemic control in type 2 diabetes mellitus (T2DM).

MATERIALS AND METHODS

Between January 2022 and September 2022, 100 patients with diabetes mellitus were retrospectively evaluated in the Department of Internal Medicine, Adıyaman, Turkey. In this study, randomly selected cases were enrolled. The patients were selected based on enrollment dates.

The demographic and laboratory data of the cases were obtained from the hospital records. This study excluded individuals under the age of 18 years, those with type 1 diabetes, those with rheumatologic conditions, such as rheumatoid arthritis or lupus, as well as those with malignancies, thyroid disorders, heart failures, chronic renal failures, and COPD, as well as those who were taking steroids. Cases were divided into two groups based on their glycemic control. In general, HbA1c levels below 7% were considered good glycemic control, while levels above 7% were considered poor glycemic control. There were 60 patients with poor glycemic control and 40 patients with good glycemic control among the patients. An analysis of liver and kidney function, fasting glucose, fasting triglycerides, HbA1c, and lipid levels was conducted. TGI is expressed on a logarithmic scale and was calculated as follows: Ln (fasting triglyceride x fasting glucose/2). TGI and laboratory values were compared between these groups.

Statistics

Data were analyzed by the statistical package SPSS for Windows 22.0 (SPSS Inc). A Kolmogorov-Smirnov test and a Shapiro-Wilk test were applied to assess whether or not the data was normally distributed. In the case of normally distributed parameters, the independent T-test was used to assess statistical significance. In the case of nonparametric parameters, the Mann-Whitney U test was used to determine statistical significance. The cutoff value for TGI was determined by analysis of the receiver operating characteristic (ROC) curve, which was evaluated in terms of poor glycemic control. $P < 0.05$ was considered statistically significant for comparisons.

RESULTS

A total of 100 T2DM patients were included in this study: 60 poor glycemic cases and 40 good glycemic cases. It was determined that the mean TGI of cases in the group with good glycemic control was 4.88±0.24, whereas the mean TGI of cases in the group with poor glycemic control was 5.17±0.33. When comparing the two groups in terms of TGI, a statistically significant difference was found between them (p-value <0.01, Tab. 1). The mean HDL cholesterol of cases in the group with good glycemic control was 45.6±11.05, while the mean of cases in the group with poor glycemic control was 40.9±10.3. When comparing these groups in terms of HDL cholesterol, a statistically significant difference was found between them (p-value=0.03, Tab. 1).

Table 1. Comparison of normally distributed parametric measures for glycemic regulation

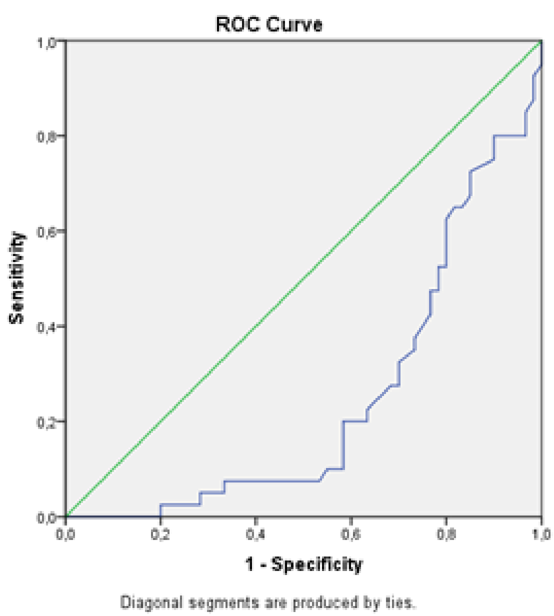
Parameters	Poor glycemic control Mean±SD (n=60)	Good glycemic control Mean±SD (n=40)	P values
Age (year)	56.8±10.2	58.7±12.2	0.40
TGI	5.17±0.33	4.88±0.24	**<0.01**
LDL cholesterol (mg/dL)	122±31.7	117.2±35.4	0.47
HDL cholesterol (mg/dL)	40.9±10.3	45.6±11.05	**0.03**
Total cholesterol (mg/dL)	203.8±44.8	198±43.08	0.52
Glucose (mg/dL)	199.6±84.8	123.4±24.7	**<0.01**
Triglycerides (mg/dL)	212.8±179.1	158.02±75.2	0.11
ALT (U/L)	19.6±8.9	19.8±16.2	0.12
Creatinine (mg/dL)	0.7±0.2	0.7±0.2	0.92
HbA1c %	9.1±1.5	6.3±0.4	**<0.01**

Abbreviations
TGI: Triglyceride-Glucose Index
SD: Standard deviation

No statistically significant differences were found between the groups with poor glycemic control and those with good glycemic control in terms of age, total cholesterol, LDL cholesterol, triglycerides, ALT, and creatinine levels (p-values >0.05, Table 1).

Demographic and laboratory data are summarized in Tab. 1.

The capability of TGI to predict poor glycemic control was estimated by ROC curve analysis, and the value under the curve (AUC) of the analysis is shown in Figure 1 and Table 2. It was found that TGI was statistically significant in predicting poor glycemic control. The optimal cutoff value for poor glycemic control was 4.88 with a sensitivity of 47.5% and a specificity of 78.3% (AUC=0.24, 95 Cl: 0.15-0.34) (Figure 1 and Table 2).



The area under the curve				
Test Result Variable: TGI				
Area	Std. Error	*P* value	Asymptotic 95% Confidence Interval	
			Lower bound	Upper bound
0,245	0,048	<0,01	0,151	0,340

Figure 1 and related Table 2. Receiver operating characteristic curve. The optimal cutoff value for poor glucose regulation was 4.88 with a sensitivity of 47.5% and specificity of 78.3% (AUC=0.24, 95 Cl: 0.15-0.34).

DISCUSSION

The initial step in the development of type 2 diabetes is insulin resistance (IR). Timely diagnosis of IR is crucial to prevent diabetes-related complications. To determine insulin resistance, the euglycemic insulin clamp is the gold standard. Since this method is invasive and expensive, it is not used in clinical practice. HOMA-IR is an alternative to the euglycemic insulin clamp. This method requires insulin measurement. In clinical practice, it is not routinely possible to measure insulin levels.

Recently, TGI has been preferred over HOMA-IR because it is a cost-effective and convenient method that does not require insulin measurement. In a study carried out by Guerrero-Romero F et al, the most appropriate value of the TGI for diagnosis of insulin resistance was 4.68, which showed the highest sensitivity (96.5%) and specificity (85.0%; area under the curve + 0.858) (1). Even though TGI is a parameter that has just entered the literature, its association with some diseases has been studied. Relevant results have been reported. In a study published by Yılmaz M et al, it was found that the TGI level was statistically significantly higher among patients with erectile dysfunction than in the control group (2). In a study published by da Silva A et al, it was found that TGI was associated with an increased prevalence of symptomatic coronary heart disease (3). In some unique studies conducted in parallel with this research, a strong association between coronary artery disorder and TGI has been determined (4-9). In a study conducted by Shi YY et al, a statistically significant association was observed between high TGI and depression (10). In a study carried out by Tutunchi H et al, a significant association was found between excessive TGI levels and the progression of liver fibrosis (11). In a study by Gao JW et al, a significant association was found between TGI and peripheral artery disease (12). In a study by Miao M et al, higher TGI was associated with carotid atherosclerosis as measured by cIMT in patients with ischemic stroke (13). In a study by Fritz J et al, TGI was linked with an increased risk of cancers of the digestive system (14). In a study carried out by Liu L et al, TGI was connected with diabetic nephropathy in patients with type 2 diabetes (15). In a study by Hong S et al, TGI was related to an increased risk of dementia (16). In a study by Zhao Y et al, elevated TGI was associated with an independent predictor of ischemic stroke in the general population, and insulin resistance may be positively associated with future stroke risk (17). In a study by Kim JA et al, elevated TGI before pregnancy was associated with the risk of gestational diabetes (18). In a study by Liu YT et al (19), a strong association was found between TGI and nonalcoholic fatty liver disease (NAFLD) (19). In a study by Wang Z et al, TGI was a reliable and independent predictor of future development of T2DM (20).

CONCLUSION

Early detection of insulin resistance is very critical for the prevention of diabetes and other IR-related diseases. In this present study, the relationship between TGI and blood glucose regulation was investigated. The optimal cutoff value for poor glycemic control was 4.88 with a sensitivity of 47.5% and a specificity of 78.3% (AUC=0.24, 95 Cl: 0.15-0.34). Even though TGI levels were significantly associated with poor glycemic control ($p < 0.05$), optimal cutoff values had low specificity and sensitivity. Therefore, future studies are needed in order to determine the value of TGI in screening glycemic control in patients with T2DM.

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Conflict of Interest Statement: The authors declare that they have no conflict of interest.

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