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ORIGINAL ARTICLE

Association between Triglyceride-Glucose (TyG) Index and Severity of Coronary Artery Disease Assessed by SYNTAX Score

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Abstract:

Background:Trigyceride-glucose (TyG) index is a composite indicator composed of triglyceride (TG) and fasting blood glucose (FBS). It is a simple, reliable and easily accessible marker of insulin resistance (IR) which is associated with different metabolic and cardiovascular diseases (CVD) including coronary artery disease (CAD).

Objective: To investigate the correlation between the TyG index and cardiovascular risk factors, and the predictive value of TyG index with severity of CAD assessed by SYNTAX score.

Methods: This cross-sectional analytical study was done in the Department of Cardiology, Bangladesh Medical University, Dhaka, Bangladesh, from January 2025 to June 2025 including a total of 50 patients undergoing coronary angiogram (CAG) during the index hospitalization. The TyG index was calculated as Ln [fasting triglyceride (mg/dL) ×fasting glucose (mg/dL)]/2. Linear regression analysis were done to assess relationship between cardiovascular risk factors and TyG index. The severity of CAD was assessed by the SYNTAX score and logistic regression analysis was done to assess predictive value of TyG index with severity of CAD.

Results: On the basis of median TyG index level level (9.33) study population were divided into two groups (low TyG index and high TyG index). In univariate linear regression analysis showed positive relation of TyG index with male gender (p=0.039), diabetes mellitus (p<0.001), dyslipidaemia (p=0.004), FBS (p=0.008) and TG/HDL ratio (p<0.001). Multivariate linear regression analysis further indicated diabetes mellitus (p=0.002) and TG/HDL ratio (p<0.001) were independently associated with TyG index. ROC curve analysis revealed strong relationship between TyG index and intermediate to high SYNTAX score with AUC of 0.799 and cut of value 9.53 yielded a sensitivity of 75.0% and a specificity of 76.5%.In univariate logistic regression analysis showed smoking (p=0.012) and TyG index (p=0.017) were significant predictors of intermediate to high SYNTAX score(≥23). On multivariate logistic regression analysis also showed TyG index (p=0.034) was independent predictor of intermediate to high SYNTAX score.

Conclusion: TyG index has strong correlation with different clinical risk factors like male gender, diabetes mellitus, dyslipidemia. TyG index may be considered as independent predictor of intermediate to high SYNTAX score. As it is a simple, easily accessible and inexpensive marker, it can be used for risk stratification before CAG to assess severity of CAD.

Keywords: CAD, TyG index, SYNTAX score.

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Introduction:

Cardiovascular disease (CVD) is the leading cause of morbidity and mortality worldwide. Therefore, it is important to early identify individuals at high risk of developing future adverse cardiovascular events. The discovery and prevention of risk factors has significantly reduced prevalence and mortality of coronary artery disease (CAD) but the number is still high.[1]More sensitive and easier predictors needed to identify to assess severity

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of CAD and to formulate appropriate management strategies including interventional procedures.Expansion of unhealthy lifestyles and dietary habits has gradually increased the incidence of insulin resistance (IR).[2] IR is a hallmark of metabolic syndrome (MetS) and is considered to be a key risk factor for cardio-metabolic diseases.[3] IR leads to the reduction of tissue response to insulin stimulation, resulting an imbalance in glucose metabolism, chronic hyperglycemia, oxidative stress and inflammatory reaction, thereby affecting cardiovascular damage.[4] Previous studies have shown that higher IR is not only significantly associated with development and progression of CAD, but also with increased risk of adverse cardiovascular events.[5–7]However, direct measurement methods of IR (the hyperinsulinemic euglycemic glucose clamp and the insulin suppression test) are invasive, costly, and complicated procedures[8]. Simple, reliable and easily accessible markers of IR are required for epidemiological study and clinical practice. High levels of triglyceride (TG) and fasting blood glucose (FBG) are the components of MetS, which is one of the most important risk factors for CVD.[3] The combination of both indicators, the triglyceride-glucose (TyG) index, has been reported to be significantly correlated with IR and has been proposed as a simple and reliable substitute or surrogate marker of IR[9]. Most of the relevant studies focused on the impact of the TyG index on metabolic diseases.[10–12] Several recent studies have showed the association of the TyG index with vascular disease, but there are limited evidence of association between TyG index and the severity of coronary lesions.[1]Coronary angiogram (CAG) is the gold standard method to diagnose and identify the severity and complexity of CAD. In clinical practice, a large number of scoring systems and laboratory parameters have been used for risk stratification of patients. For quantification of coronary lesions from CAG with respect to their number, location, and complexity, the SYNTAX (Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery) score has been developed as a comprehensive scoring tool.[13]Although this scoring system has many advantages, it require an invasive method CAG to perform the scoring. Therefore, clinicians still need an easily accessible, cost-effective, noninvasive practical and precise tool to carry out risk stratification to determine the extent and severity of CAD. If the association between TyG index and SYNTAX score is found, it can readily be used as a tool to predict severe CAD. Therefore, the purpose of this study was to investigate the correlation between the cardiovascular risk factors and TyG index; the association and predictive value of TyG index with severity of CAD assessed by SYNTAX score.

Methods*:*

2.1. Study design and population: The present cross-sectional, analytical study was carried out in the Department of Cardiology, Bangladesh Medical University (BMU), Dhaka, Bangladesh from January 2025to June 2025. A total of 50 patients undergoing CAG during the index hospitalization were studied after selecting by purposive non random sampling method. Informed written consent was obtained from all subjects prior to inclusion in the study.

2.2 Data collection and definitions: Data were collected in preformed structured data collection sheet. These included demographic data, medical history, laboratory parameters, and basic medication information. A medical professional also collected blood samples from each subject's fasting venous blood, which was subsequently used to determine various parameters including fasting plasma glucose (FPG), total cholesterol (TC), triglycerides (TG), high density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C). The TyG index was calculated as Ln [fasting triglycerides (mg/dL) × fasting glucose (mg/dL)]/2.[9]The angiographic data were obtained from the cardiac catheterization laboratory records. More than 50% stenosis is usually related to the occurrence of CAD. So CAD was defined in our study as luminal stenosis of ≥50% in at least one major coronary artery (left anterior descending, left circumflex, and right coronary arteries.[14]The SYNTAX score for quantifying the severity of coronary lesions was calculated by using the score calculator (version 2.28) in the SYNTAX score web site.A low score was defined as ≤22, an intermediate score as 23-32, and a high score as ≥33. The higher the score the more severe was the disease. Patient with SYNTAX score ≥23 was considered to have more severe CAD according to this definition and considered asintermediate to high SYNTAX score.[13]

2.3. Statistical Analysis. Statistical analysis of all data was performed using SPSS 26.0 (IBM Corp, New York, NY, USA) at significance level of $p < 0.05$. Continuous variables were presented as the mean±SD or median (IQR) according to the presence or absence of normal distribution, and categorical data were expressed as frequencies and percentages. To compare the baseline characteristics, the patients were divided into two groups by the median value of TyG index level (9.33) of the study population: low TyG index group (d"9.33) and high TyG

index group (>9.33). Differences in continuous variables classified by the median of the TyG index were assessed by independent t-testand differences in categorical variables were evaluated by the Chi-square test. Linear regression analyses were performed to reveal the factors associated with the TyG index, and the selection of variables was made based on a forward stepwise method in the multivariate model. Diagnostic performances of the TyG index was assessed by receiver operating characteristic (ROC) curve analysis. Logistic regression analysis was applied to evaluate the independent predictors ofintermediate to high SYNTAX score (e" 23), and the variables withp value of <0.05 were selected as potential risk factors and included in the multivariate model.

Results:

Study populations were divided into two groups by the median value of TyG index (9.33); group I: low TyG index (d"9.33) and group II: high TyG index group (>9.33). Mean age of study population was 56.40±9.58 and 51.72 ±8.37 years in respectively in group I & II. Male patients were predominant (84% vs 60%) in both groups. Hypertension was the commonest risk factor of CAD in both groups (52% vs 76%) followed by diabetes mellitus (32% vs 84%) and smoking (40% vs 56%)(Table:I).

In univariate linear regression analysis shows positive relation of TyG index with male gender (B=0.302, â=0.294, p=0.039), diabetes mellitus (B=0.446, â=0.447, p<0.001), dyslipidaemia (B=0.373, â=0.398, p=0.004), FBS (B=0.005, â=0.369, p=0.008) and TG/HDL ratio level (B=0.100, â=0.474, p<0.001). In multivariate linear regression analysis shows diabetes mellitus (B=0.36, â=0.39, p= 0.002) and TG/HDL ratio level (B=0.11, â=0.52, p<0.001)were independently associated with TyG index.(Table:II).

ROC curve analysis revealed strong relationship between TyG index and intermediate to high SYNTAX with AUC of 0.799 (95% CI 0.555-0.903, p=0.01); at cut of value 9.53 yielded a sensitivity of 75.0% and a specificity of 76.5% (Figure:1).

In univariate logistic regression analysis shows smoking (OR 5.50, 95% CI 1.45-20.84, p=0.012) and TyG index (OR 6.99, 95% CI 1.42-34.45, p=0.017) were found to be significant predictors of intermediate to high SYNTAX score. On multivariate logistic regression analysis also showed smoking (OR 4.95, 95% CI 1.21-20.23, p=0.026) and TyG index (OR 6.36, 95% CI 1.15-35.08, p=0.034) were independent predictors of intermediate to high SYNTAX score (Table:III).

Table-I

Baseline characteristics of the study population (N=50).

Variables	Total (n=50)	Group I (n=25)	Group II (n=25)	P value
Age, years (Mean ± SD)	54.06 ±9.21	56.40±9.58	51.72 ±8.37	0.072
	(35-70)	(40-70)	(35-68)	
Gender, n (%)				
Male	36 (72)	21 (84)	15 (60)	
Female	14 (28)	04 (16)	10 (40)	
0.059				
Smoking (Yes)	24 (48)	10 (40)	14 (56)	0.258
Hypertension(Yes)	32 (64)	13 (52)	19 (76)	0.077
Diabetes mellitus (Yes)	29 (58)	08 (32)	21 (84)	<0.001
Dyslipidaemia	21 (42)	05 (20)	16 (64)	0.002
Family history of CAD	15 (30)	09 (36)	06 (24)	0.355
BMI (Mean ± SD)	25.26 ±3.77	24.90 ±4.40	25.62 ±3.40	0.508
	(17.00-35.00)	(17.00-35.00)	(17.40-33.70)	

Group-I: Low TyG index(d≤9.33), Group-II: High TyG Index(>9.33).

Table-II

Univariate and multivariate linear regression analyses for the TyG index with traditional cardiovascular risk factors and other variables.

Variables	Univariate			Multivariate		
	B	Standard â	P value	B	Standard â	P value
Age	0.01	0.23	0.116			
Male gender	0.30	0.29	0.039	0.17	0.16	0.100
Smoking	0.18	0.19	0.172			
HTN	0.25	0.26	0.068			
Diabetes mellitus	0.45	0.48	<0.001	0.36	0.39	0.002
Dyslipidemia	0.37	0.40	0.004	0.07	0.08	0.499
Family history of CAD	0.19	0.19	0.183			
BMI	0.01	0.09	0.558			
FBS	0.01	0.37	0.008	0.00	0.24	0.053
TG/HDL-C ratio	0.10	0.47	<0.001	0.11	0.52	<0.001

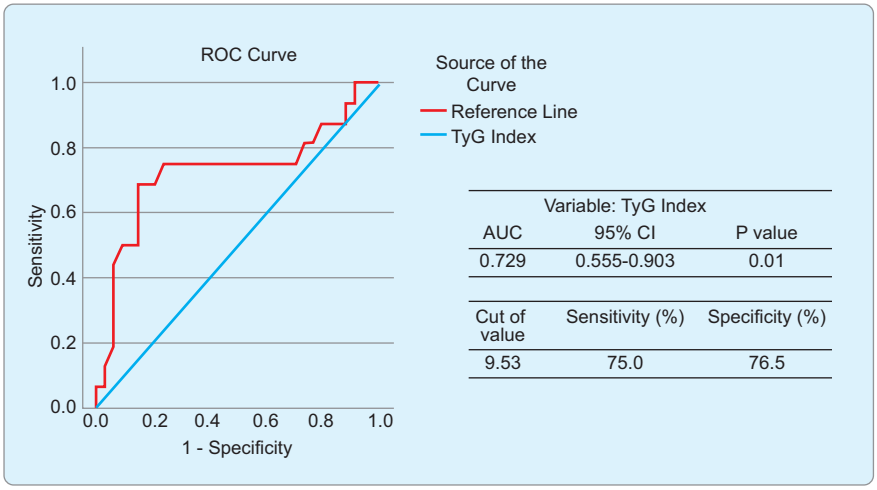

Figure- 1: *ROC curve analysis for the use of TyG index in the detection of intermediate to high SYNTAX.*

Table-III

Univariate and multivariate logistic regression analyses of variables associated with moderate to highSYNTAX score (≥23).

Variables	Univariate			Multivariate		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Age	0.94	0.88-1.01	0.098			
Male gender	2.07	0.49-8.80	0.323			
Smoking	5.50	1.45-20.84	0.012	4.95	1.21-20.23	0.026
HTN	0.91	0.27-3.12	0.880			
Diabetes mellitus	1.96	0.56-6.85	0.294			
Dyslipidemia	1.62	0.49-5.36	0.433			
Family history of CAD	0.70	0.18-2.66	0.598			
BMI	1.16	0.98-1.38	0.091			
FBS	1.00	0.99-1.02	0.619			
TG/HDL-C ratio	1.220	0.927-1.606	0.156			
TyG index	6.993	1.420-34.447	0.017	6.36	1.15-35.08	0.034

Discussion:

Series of studies have demonstrated strong association between the TyG index and insulin resistance (IR), hypertension, diabetes mellitus, metabolic syndrome and atherosclerosis.[15,16]Zheng and Mao found that the TyG index was a predictor of hypertension in Chinese population.[17]The TyG index is also considered as a predictor of type 2 diabetes mellitus.[10,12]Though the TyG index is a robust marker of metabolic syndrome, little is known about relationship between TyG index and severity of CAD. Wang et al. showed that TyG index, as an indicator for evaluating IR, may be a valuable predictor of CAD severity, while Su et al. demonstrated that TyG index was associated with severity of CAD.[1,14]Sánchez-Íñigo et al. showed that the TyG index was significantly associated with high risk of developing CVD and a good predictor for the Framingham model in the Vascular-Metabolic CUN cohort.[18]In a study Lee et al. showed that TyG index was associated with risk of coronary artery stenosis in asymptomatic patients with type-2diabetes mellitus but the severity of coronary artery stenosis was not quantified.[19] In addition, Lambrinoudaki et al. found that the TyG index was associated with carotid atherosclerosis, but this study mainly focused on subclinical vascular disease in postmenopausal women.[20]Large-scale population based survey conducted in South Korea revealed that patients with the highest TyG index had a higher risk of stroke and myocardial infarction.[21]In recent studies, Lee et al. and Kim et al. respectively, revealed that the TyG index was independently associated with arterial stiffness and coronary artery calcification in Korean adults.[22,23] These studies showed that the TyG index might serve as a biomarker for vascular disease and implied that IR reflected by the TyG index might have participated in the process of vascular remodeling and atherogenesis. Consistent with previous studies, our results also revealed the correlation of the TyG index with different metabolic risk factors, most of which were the components of metabolic syndrome and risk factors of atherosclerosis. Moreover, the TyG index had a positive correlation with the TG/HDL-C ratio which was also a marker of IR. These findings reconfirmed the correlation of the TyG index with metabolic disorder and IR.

This study evaluated the association between TyG index and severity of CADassessed by SYNTAX score. Study population were divided into two groups: group-I, patients with low TyG index and group-II,patients with high TyG index. Age, gender and BMI was not significantly different between two groups. Though a similar study showed that the median age and BMIwas significantly higher in high TyG index group.[24]In the present study regarding risk factors of CAD, diabetes mellitusand dyslipidemia were significantly higher among group-II patients than group-I patients ($p<0.05$). In addition, fasting blood glucose (FBG) and TG/HDL ratio has positive correlation with TyG index ($p<0.05$). Nearly similar findings were seen in other studies.[24,25]

The main findings of our study are as follows: TyG index is correlated with multiple cardiovascular risk factors, andTyG index is an independent predictor of intermediate to high SYNTAX score.

In our study, the number of diseased vessels and the SYNTAX score increased with increasing TyG index level, and the association between the TyG index and the SYNTAX score was related to cardio-metabolic risk factors, such as smoking, diabetes mellitus and dyslipidaemia. This suggested that higher IR represented by the TyG index makes the patients more susceptible to atherosclerosis and CVD. Further analysis showed that the TyG index might serve as a marker of severity of CAD and was independently associated with the SYNTAX score. The proatherosclerosis mechanisms of the TyG index may be ascribed to systemic inflammation, endothelial dysfunction, oxidative stress, and vascular remodeling mediated by IR.[4, 26]

Finally in multivariate regression analysis showed that, patients with a high TyG index had a significantly (6.36 times) higher chance of having intermediate to high SYNTAX scores than patients with a low TyG index (OR 6.36, 95% CI (1.15-35.08). In addition, patients who are smokers had 4.95 times more chances of having intermediate to high SYNTAX scores than non-smoker (OR 4.95, 95% CI 1.21-20.23).Simply the present study showed that the TyG index had a significantly positive correlation with smoking andintermediate to high SYNTAX score. These result exhibit similarity with the study by Mao et al., which showed that the number of diseased vessels and the SYNTAX score increased with increasing TyG index levels.[24]

Conclusion:

It may be concluded that TyG index has strong correlation with different clinical risk factors like male gender, diabetes mellitus and dyslipidemia. TyG index may be considered as independent predictor of intermediate to high SYNTAX score. As it is a simple, easily accessible and inexpensive marker, it can be used for risk stratification before CAG to assess severity of CAD.

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