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Triglyceride glucose index as a significant predictor of severity of impaired consciousness and in-hospitality mortality in cerebrovascular disease patients

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Abstract

Background: The triglyceride–glucose (TyG) index is an established surrogate marker of insulin resistance and has recently emerged as a potential predictor of adverse cerebrovascular outcomes. The present study evaluated the association of TyG index with severity of impaired consciousness and in-hospital mortality in cerebrovascular disease patients.

Material and Methods: This prospective observational study was conducted in the Postgraduate Department of Medicine, Government Medical College, Srinagar, over 18 months. A total of 150 patients with ischemic and hemorrhagic stroke were enrolled. Demographic details, comorbidities, laboratory investigations, and Glasgow Coma Scale (GCS) scores were recorded. TyG index was calculated using fasting triglyceride and glucose values. Patients were categorized according to TyG quartiles and GCS severity. Statistical analysis was performed using SPSS version 23.0.

Results: Acute ischemic stroke constituted 78.0% of cases, while hemorrhagic stroke accounted for 22.0%. High or very high insulin resistance was observed in 56.0% of patients. Median TyG index increased progressively from mild GCS impairment (8.59) to death (9.43) ($p=0.001$). A significant negative correlation was observed between TyG index and GCS score ($\rho = -0.619$, $p<0.001$). Linear regression analysis showed that each one-unit increase in TyG index predicted an approximate 3-point decline in GCS score.

Conclusion: Elevated TyG index is significantly associated with severe impaired consciousness and poor in-hospital outcome in cerebrovascular disease patients and may serve as a simple prognostic marker for early risk stratification.

Keywords: Triglyceride–Glucose Index, Cerebrovascular Disease, Insulin Resistance, Glasgow Coma Scale, In-Hospital Mortality

Introduction

Cerebrovascular diseases remain one of the leading causes of mortality and long-term disability worldwide, exerting a major social and economic burden on patients and healthcare systems. Acute cerebrovascular events, particularly ischemic and hemorrhagic strokes, frequently present with varying degrees of impaired consciousness, reflecting the severity of underlying brain injury and systemic metabolic stress[1]. In recent years, metabolic dysfunction has been increasingly recognized as an important contributor to cerebrovascular disease pathogenesis and progression. Among the emerging metabolic markers, the triglyceride glucose (TyG) index has gained attention as a simple and inexpensive surrogate marker of insulin resistance[1,2]. Insulin resistance contributes significantly to endothelial dysfunction, chronic inflammation, oxidative stress, and atherosclerosis, all of which are central to cerebrovascular pathology. Persistent hyperglycemia and elevated triglyceride levels impair nitric oxide–mediated vasodilation and promote vascular injury, thereby increasing susceptibility to ischemic brain damage[2,3]. The TyG index, calculated from fasting triglyceride and glucose concentrations, reflects underlying metabolic derangement and can be easily obtained in routine clinical practice, making it useful for early risk stratification in acute stroke settings[2,3].

The severity of impaired consciousness in cerebrovascular disease is closely associated with the extent of neuronal injury, cerebral edema, and systemic complications. Metabolic disturbances may worsen neuronal damage through excitotoxicity, mitochondrial dysfunction, and inflammatory cascades[4,5]. Patients with elevated TyG index values may therefore represent a subgroup with greater metabolic stress and poorer neurological recovery. Furthermore, insulin resistance may contribute to exaggerated stress hyperglycemia, impaired immune responses, and a prothrombotic state, thereby increasing the risk of adverse in-hospital outcomes and mortality[5,6]. The TyG index has practical importance because it is derived from routinely available laboratory parameters and can be applied even in resource-limited settings[6]. When combined with neurological examination and neuroimaging findings, it may improve early prognostication in cerebrovascular disease patients. Increasing evidence also suggests that metabolic syndrome, diabetes mellitus, and dyslipidemia actively influence the severity and recovery of stroke patients, emphasizing the need for integrated metabolic assessment in acute stroke care[7,8].

Therefore, the present study was undertaken to evaluate the triglyceride glucose index as a significant predictor of severity of impaired consciousness and in-hospital mortality in cerebrovascular disease patients.

Aims and Objectives

Aim

- Aim of present study is to investigate the predictive ability of TyG index on severity of impaired consciousness and in hospital mortality in patients with CVD.

Objectives

- To assess the relationship between TyG Index and Disturbance of consciousness in patients with CVD.
- To assess the relation between TyG index and in hospital mortality from CVD.

Material and Methods

This prospective observational study was conducted in the Postgraduate Department of Medicine, Government Medical College, Srinagar, a tertiary care referral center in Jammu and Kashmir, over a period of 18 months. The study included patients admitted to the general medicine wards, casualty, and medical intensive care unit with a diagnosis of cerebrovascular disease. A total of 150 adult patients with acute cerebrovascular disease were enrolled using a consecutive sampling technique. Patients with both ischemic stroke and hemorrhagic stroke were included after confirmation by detailed clinical evaluation and radiological imaging using non-contrast computed tomography (NCCT) or magnetic resonance imaging (MRI) of the brain. Only patients aged more than 18 years in whom fasting blood samples could be obtained within 24 hours of admission were included in the study. Patients with severe comorbid illnesses likely to independently influence prognosis, including advanced malignancy, end-stage renal disease, decompensated liver disease, severe chronic obstructive pulmonary disease, and advanced heart failure, were excluded. Patients with pre-existing severe disorders of consciousness, traumatic brain injury, traumatic subarachnoid hemorrhage, follow-up duration less than 24 hours, delayed presentation beyond 24 hours of symptom onset, incomplete baseline data, or prior administration of osmotic agents such as mannitol or glycerol within 8 hours before sampling were also excluded.

Detailed demographic data, clinical history, personal habits, comorbidities, drug history, and systemic and neurological examinations including Glasgow Coma Scale (GCS) assessment were recorded for all participants. Laboratory investigations included fasting blood glucose, lipid profile, complete blood count, renal and liver function tests, and other routine investigations. Radiological and cardiac assessments included CT/MRI brain, electrocardiography, and chest radiography.

Patients were categorized into four TyG quartiles: Q1 (<8.429), Q2 (8.429–8.823), Q3 (8.824–9.251), and Q4 (>9.251). Based on discharge GCS, patients were further classified into mild (13–15), moderate (9–12), severe (3–8), and death categories. All patients received standard treatment as per institutional stroke management protocols independent of study participation. Patients were followed prospectively from admission until discharge or in-hospital death. Outcome measures included severity of impaired consciousness, discharge GCS score, in-hospital mortality, and duration of hospital stay.

Data were collected using a predesigned case record form and entered into Microsoft Excel for analysis using SPSS version 23.0. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, while categorical variables were expressed as frequencies and percentages. Appropriate parametric and non-parametric statistical tests including Student's t-test, Mann–Whitney U test, ANOVA, Kruskal–Wallis test, Chi-square test, and Fisher's exact test were applied. Correlation and regression analyses were performed to assess the relationship between TyG index and neurological outcomes. A p-value of <0.05 was considered statistically significant. The study was conducted in accordance with the Declaration of Helsinki after obtaining approval from the Institutional Ethics Committee of Government Medical College, Srinagar. Written informed consent was obtained from all participants or their legally authorized representatives prior to enrollment. Confidentiality of patient information was strictly maintained throughout the study.

Results

A total of 150 patients with cerebrovascular disease were included in the present study and evaluated for the association between triglyceride-glucose (TyG) index, severity of impaired consciousness, and in-hospital mortality. Demographic characteristics, comorbidities, stroke type, TyG index categories, Glasgow Coma Scale (GCS) outcomes, and statistical correlations between TyG index and neurological severity were analyzed.

The findings are presented in the following tables.

Table 1: Study of study population (male and female) as per age in years

Age Group	Total		Male		Female	
	No.	%	No.	%	No.	%
41–50 years	18	12.0%	11	7.3%	7	4.7%

51–60 years	39	26.0%	25	16.7%	14	9.3%
61–70 years	55	36.7%	32	21.3%	23	15.3%
>70 years	38	25.3%	22	14.7%	16	10.7%
Total	150	100.0%	90	60.0%	60	40.0%

The majority of patients belonged to the 61–70 years' age group (36.7%), followed by 51–60 years (26.0%). Overall, males constituted 60.0% of the study population, showing male predominance across all age groups.

Table 2: Study of study population as per gender, occupation, comorbidity, type of stroke, TyG Index Category and Outcome (GCS)

Variable	Category	No. of Patients	Percentage
Gender	Female	60	40.0%
	Male	90	60.0%
Occupation	Business	16	10.7%
	Carpenter	3	2.0%
	Farmer	30	20.0%
	Housewife	30	20.0%
	Laborer	45	30.0%
	Officer	14	9.3%
	Teacher	12	8.0%
Comorbidity	Hypertension	105	70.0%
	Diabetes Mellitus	60	40.0%
	Type II DM + HTN	40	26.7%
	Atrial Fibrillation	10	6.7%
	Smoking	60	40.0%
Type of Stroke	Acute hemorrhagic stroke	33	22.0%
	Acute ischemic stroke	117	78.0%
TyG Index Category	Low IR (<8.428)	27	18.0%
	Moderate IR (8.429–8.823)	39	26.0%
	High IR (8.824–9.251)	48	32.0%
	Very High IR (>9.251)	36	24.0%
Outcome Category	Mild GCS (13–15)	57	38.0%
	Moderate GCS (9–12)	33	22.0%
	Severe GCS (3–8)	54	36.0%
	Death	6	4.0%

The study cohort showed a predominance of male patients (60.0%) compared to females (40.0%). The majority of patients belonged to the 61–70 years age group (36.7%), followed by 51–60 years (26.0%). Overall, males constituted 60.0% of the study population, showing male predominance across all age groups. Hypertension was the most common comorbidity (70.0%), followed by diabetes mellitus and smoking history (40.0% each). Combined hypertension and diabetes mellitus were present in 26.7% of patients. Acute ischemic stroke was the predominant cerebrovascular event, accounting for 78.0% of cases, while hemorrhagic stroke constituted 22.0%. High insulin resistance was the most common category (32.0%), followed by moderate insulin resistance (26.0%). Overall, the majority of patients had moderate-to-very high insulin resistance. Mild GCS impairment was observed in 38.0% patients, while severe GCS impairment was present in 36.0%. In-hospital mortality was recorded in 4.0% of patients.

Table 3: Distribution of TyG Index in Hemorrhagic and Ischemic Stroke, and, Comparison of TyG Index Scores among GCS Category

Variable	Category	Median	Q1	Q3	P value
Type of Stroke	Acute hemorrhagic stroke	9.16	8.59	9.51	0.08
	Acute ischemic stroke	8.84	8.54	9.16	
GCS Outcome	Mild	8.59	8.34	8.79	0.001
	Moderate	8.75	8.35	9.15	
	Severe	9.21	9.02	9.42	
	Death	9.43	9.35	9.51	

Patients with hemorrhagic stroke had a slightly higher median TyG index compared to ischemic stroke patients; however, the difference was not statistically significant (p=0.08).

Median TyG index increased progressively with worsening GCS category and death. Patients who died had the highest median TyG index (9.43). The difference across categories was statistically significant (p=0.001).

Table 4: Pairwise Comparison of GCS Categories

Comparison	Standardized Test Statistic	Adjusted P value
Mild vs Moderate	-1.020	1.000
Mild vs Severe	-7.442	<0.001
Mild vs Death	4.455	<0.001
Moderate vs Severe	-5.386	<0.001
Moderate vs Death	3.806	0.001
Severe vs Death	1.159	1.000

Significant differences in TyG index were observed between mild/moderate GCS and severe GCS or death categories. However, differences between mild and moderate GCS, and between severe GCS and death, were not statistically significant.

Table 5: Linear Regression Model Predicting GCS Score

Variable	B	Std. Error	Beta	t	P value	95% CI
Constant	37.582	3.650	—	10.295	<0.001	30.368–44.796
TyG Index	-3.010	0.408	-0.519	-7.377	<0.001	-3.816 to -2.204

Linear regression analysis demonstrated that TyG index was a significant negative predictor of GCS score. Each one-unit increase in TyG index predicted an approximately 3-point decline in GCS score, indicating worsening neurological impairment with increasing insulin resistance.

Discussion

The present study was conducted to evaluate the triglyceride–glucose (TyG) index as a significant predictor of severity of impaired consciousness and in-hospital mortality among patients with cerebrovascular disease. The study demonstrated a significant association between elevated TyG index and worsening neurological status, severe GCS impairment, and mortality. The present study showed that cerebrovascular disease was more common among older adults, particularly in the 61–70 years age group comprising 55 patients (36.7%), followed by 51–60 years with 39 patients (26.0%). Overall, 88.0% of patients were above 50 years of age. These findings are comparable with Zhang et al. (2020), who reported a mean age of 66.3 years among critically ill stroke patients[9]. Similarly, Yimo Zhou et al. (2020) reported a mean age of 64.83 ± 11.9 years among ischemic stroke patients[10], while Chen et al. (2023) documented a median age of 71 years in both cerebral hemorrhage and infarction groups[11]. The higher prevalence of cerebrovascular disease in older age groups may be attributed to increasing vascular stiffness, atherosclerosis, hypertension, diabetes mellitus, and atrial fibrillation with advancing age. In the present study, males constituted 60.0% of the study population, while females accounted for 40.0%, indicating male predominance. Similar findings were reported by Yimo Zhou et al. (2020), who observed 63.48% male patients among ischemic stroke cases[10]. Weimin Cai et al. (2023) also reported male predominance with 55.8% males among critically ill ischemic stroke patients[12]. However, Chen et al. (2023) observed a relatively balanced sex distribution in cerebrovascular disease patients[11]. The male predominance observed in the present study may be due to higher exposure to vascular risk factors such as smoking, hypertension, diabetes mellitus, and metabolic syndrome.

The occupational profile of the study population demonstrated that laborers constituted the largest group (30.0%), followed by farmers and housewives (20.0% each). This finding suggests that a considerable proportion of patients belonged to lower socioeconomic and manual labor backgrounds. Although previous studies evaluating TyG index did not specifically analyze occupation, the predominance of laborers and farmers may indirectly reflect poor awareness and inadequate control of vascular risk factors. Hypertension was the most common comorbidity observed in the present study, affecting 70.0% of patients, followed by diabetes mellitus and smoking history in 40.0% each. Combined diabetes mellitus and hypertension were present in 26.7% of cases. Wang et al. (2022) reported that elevated TyG index was significantly associated with hypertension, stroke, and cardiovascular disease[13]. Le Wang et al. (2020) also demonstrated that higher TyG index values were associated with adverse cardiovascular events among diabetic patients[14]. Similarly, Liu et al. (2022) observed increased recurrence and mortality among ischemic stroke patients with higher TyG index values[15]. These findings support the strong relationship between metabolic dysfunction, vascular risk factors, and cerebrovascular disease severity. Acute ischemic stroke was the predominant cerebrovascular event in the present study, accounting for 78.0% of cases, while hemorrhagic stroke constituted 22.0%. This pattern is comparable with epidemiological studies showing that ischemic stroke forms the majority of stroke cases. Ahmed et al. (2024) reported that ischemic stroke contributes to approximately 87% of stroke cases, while hemorrhagic stroke accounts for around 13%[16]. Lee et al. (2019) demonstrated that higher TyG index values were significantly associated with mortality in acute ischemic stroke patients[17]. Yimo Zhou et al. (2020) also reported increased stroke recurrence, neurological worsening, and mortality in ischemic stroke patients with elevated TyG index[10]. The predominance of ischemic stroke in the present study further supports the role of metabolic dysfunction and insulin resistance in cerebrovascular pathology.

The present study demonstrated that 82.0% of patients had moderate-to-very high insulin resistance based on TyG index categories. High insulin resistance was the most common category (32.0%), followed by moderate insulin resistance (26.0%). Yimo Zhou et al. (2020) reported a median TyG index of 8.73 among ischemic stroke patients and observed significant associations between higher TyG quartiles and adverse outcomes[10]. Zhang et al. (2020) demonstrated that each unit increase in TyG index significantly increased hospital mortality[9]. Similarly, Weimin Cai et al. (2023) reported significant associations between elevated TyG index and hospital as well as ICU mortality[12]. These findings indicate that metabolic dysfunction reflected by elevated TyG index is highly prevalent among cerebrovascular disease patients and may influence disease severity and prognosis. The present study observed mild GCS impairment in 38.0% of patients, severe GCS impairment in 36.0%, moderate impairment in 22.0%, and mortality in 4.0% of patients. Chen et al. (2023) reported severe disturbance of consciousness and increased mortality among patients with higher TyG index values in both hemorrhagic and ischemic stroke groups[11]. Zhang et al. (2020) also documented increased hospital mortality with elevated TyG index[9]. The present study findings therefore support the role of TyG index as an indicator of neurological severity and adverse in-hospital outcome. The median TyG index was slightly higher among hemorrhagic stroke patients (9.16) compared to ischemic stroke patients (8.84); however, the difference was not statistically significant (p=0.08). Zhang et al. (2020) reported a stronger association of TyG index with ischemic stroke mortality compared to hemorrhagic stroke[9]. Chen et al. (2023), however, demonstrated that increasing TyG index was associated with severe disturbance of consciousness and higher mortality in both hemorrhagic and ischemic stroke patients[11]. The findings of the present study therefore suggest that TyG index may have prognostic significance irrespective of stroke subtype.

A progressive increase in median TyG index was observed with worsening GCS outcome and mortality. Median TyG index increased from 8.59 in mild GCS patients to 9.43 among patients who died, with a statistically significant difference (p=0.001). Chen et al. (2023) similarly reported that higher TyG index values were associated with severe consciousness disturbance and mortality in cerebrovascular disease patients[11]. Zhang et al. (2020) found that elevated TyG index significantly increased hospital mortality[9], while Weimin Cai et al. (2023) demonstrated strong associations between TyG index and all-cause mortality in critically ill ischemic stroke patients[12]. These findings strongly support the prognostic role of TyG index in assessing neurological severity and mortality risk. Pairwise comparison analysis demonstrated that TyG index significantly differentiated mild and moderate GCS categories from severe GCS impairment and death. However, differences between mild and moderate GCS categories, as well as severe GCS and death, were not statistically significant. These findings suggest that TyG index is particularly useful in distinguishing patients with severe neurological compromise from those with less severe impairment. Similar observations regarding worsening neurological outcomes with elevated TyG index were reported by Chen et al. (2023) and Zhang et al. (2020)[9,11].

The present study demonstrated a strong negative correlation between TyG index and GCS score (ρ = -0.619, p<0.001), indicating that increasing insulin resistance was associated with worsening neurological status. Yimo Zhou et al. (2020) also observed neurological worsening among patients in the highest TyG quartile[10]. Ying Yang and Xiangting (2023), in a systematic review and meta-analysis, reported that elevated TyG index was significantly associated with ischemic stroke recurrence and mortality[18]. These findings support the association between higher TyG index and poor neurological outcomes in cerebrovascular disease patients. Linear regression analysis in the present study showed that TyG index was a significant negative predictor of GCS score, with each one-unit increase in TyG index predicting an approximately 3-point decline in GCS score. Zhang et al. (2020) demonstrated increased mortality risk with rising TyG index values[9], while Liu et al. (2022) reported increased all-cause mortality among patients in the highest TyG quartile[15]. Chen et al. (2023) also confirmed the association between elevated TyG index and severe disturbance of consciousness and mortality[11]. These findings indicate that TyG index is an important independent predictor of neurological severity and adverse outcome in cerebrovascular disease patients.

Conclusion

The present study concludes that the triglyceride–glucose (TyG) index is a significant predictor of severity of impaired consciousness and in-hospital mortality in cerebrovascular disease patients. Higher TyG index values were associated with lower GCS scores, severe neurological impairment, and poor in-hospital outcomes. A significant negative correlation was observed between TyG index and GCS score, with increasing TyG index predicting worsening neurological status. Since the TyG index is simple, inexpensive, and derived from routine laboratory parameters, it may serve as a useful tool for early risk stratification and prognostic assessment in cerebrovascular disease patients.

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