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ORIGINAL ARTICLE

Triglyceride-Glucose Index: Evaluation as a Potential New Risk Marker for SYNTAX Score in Acute Coronary Syndrome

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Abstract

Background: The triglyceride glucose (TyG) index is known to indicate conditions such as metabolic syndrome and atherosclerotic process. SYNergy between PCI with TAXUS (SYNTAX) and Cardiac Surgery scoring systems (SS) can show coronary anatomic severity and complexity because it is a quantitative and reproducible basic measurement before revascularization. There is no study in the literature investigating the relationship between the TyG index and the SYNTAX SS.

Objective: This study aims to investigate a potential association between the TyG index and the SYNTAX score in patients with acute coronary syndrome (ACS).

Methods: We retrospectively analyzed 214 patients hospitalized for ACS. Patient demographics and clinical characteristics were recorded, and participants were categorized into low, intermediate, and high SYNTAX score groups. The relationship between SS and TyG index was then evaluated using statistical analysis (chi-square test, $p < 0.05$).

Results: The mean age of participants was 63.15 ± 12.69 years, with 67.8% being male. The majority (65.4%) had low SS, while 24.3% had intermediate SS, and 10.3% had high SS. As expected, the SYNTAX score correlated significantly with diabetes mellitus (DM) ($p < 0.001$). However, no statistically significant association was found between the SYNTAX score and the TyG index ($p = 0.312$).

Conclusion: In patients diagnosed with ACS and undergoing coronary angiography (CAG), our study confirmed a strong link between SYNTAX score and DM. Unexpectedly, we did not find a significant relationship between the TyG index and SYNTAX score, suggesting that TyG may not directly reflect coronary artery disease (CAD) complexity as assessed by the SS.

Keywords: Triglycerides; Acute coronary syndrome; Coronary Artery Disease.

Introduction

Coronary artery disease (CAD) is the most common cause of death worldwide. In Europe, cardiovascular diseases account for 45% of deaths in women and 38% in men under the age of 75.[1] According to the available data, the World Health Organization predicts that deaths due to CAD will increase by 120% in women and 137% in men in the next twenty years.[2] CAD presents both a serious economic burden and a social problem due to its negative effects on quality of life. According to US data, CAD accounts for one-fourth of all inpatient treatment expenses, amounting to 71.2 billion dollars.[3] Clinically, CAD manifests as silent ischemia, stable angina pectoris, acute coronary syndrome (ACS), heart failure, and sudden death.[4] ACS encompasses all clinical symptoms associated with acute myocardial ischemia. It is classified into three different clinical categories: ST-segment elevation myocardial infarction (STEMI), non-ST segment elevation myocardial infarction

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Central Illustration: Triglyceride-Glucose Index: Evaluation as a Potential New Risk Marker for SYNTAX Score in Acute Coronary Syndrome

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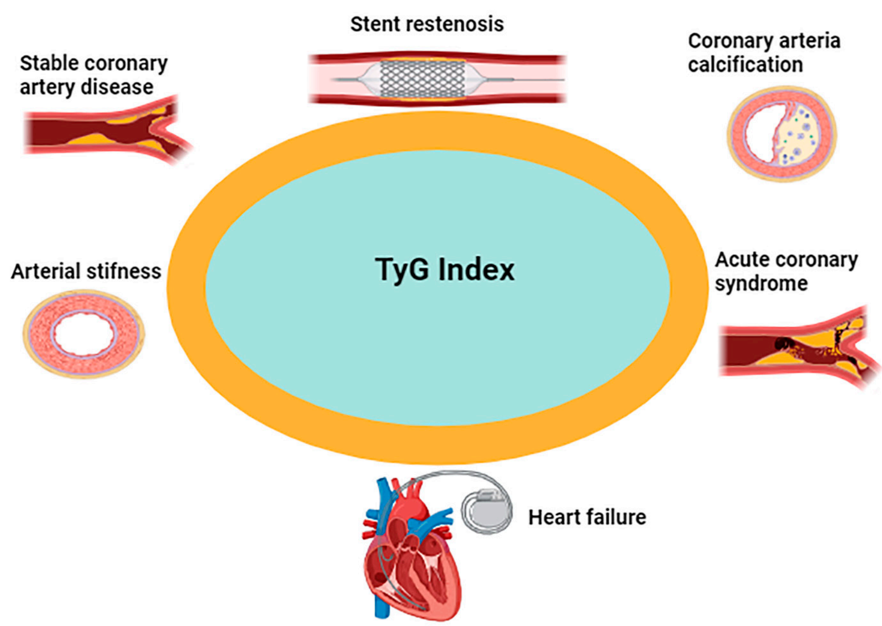

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Triglyceride-Glucose Index as a Marker in Cardiovascular Diseases. TyG: triglyceride-glucose.

(NSTEMI), and unstable angina pectoris (USAP). Since ACS is a life-threatening atherothrombotic disease, risk stratification criteria have been developed to guide decisions on tailored drug therapy or revascularization strategies for each patient. One such criterion is the SYNTAX scoring system (SS).[5] The severity, degree, and quality of residual coronary stenosis after percutaneous coronary intervention (PCI) in patients presenting with ACS can have different effects on patient outcomes. Since the SS system is a quantitative and reproducible basic measurement before revascularization, it can indicate the severity and complexity of the coronary anatomy. It can serve as an independent prognostic variable in patients undergoing PCI.[5,6] The SS system, which was prepared angiographically by considering features such as the number of lesions, their functional significance, and location, provides important data in the evaluation of the coronary artery bed.[5]

The triglyceride-glucose (TyG) index is a relatively new parameter calculated from fasting blood glucose and triglyceride levels in determining insulin resistance.[7,8] Studies have shown that this index can be used to determine cardiovascular risk.[9] One study on patients with diabetes and CAD demonstrated that the TyG index is a useful marker in predicting clinical outcomes.[10] However, no study has investigated the relationship between the TyG index and the SYNTAX score in patients with ACS (Central Illustration).

This study aims to determine the relationship between the SS and the TyG index during coronary intensive care follow-ups of patients admitted to the coronary intensive care unit with the diagnosis of ACS.

Methods

The study analyzed retrospectively the data of 214 patients who were followed in the coronary intensive care unit between January 2022 and April 2022 with diagnoses of acute or subacute ST-elevation myocardial infarction (STEMI) and non-ST elevation myocardial infarction (NSTEMI). Excluded from the study were patients with USAP, those who did not undergo or declined coronary angiography (CAG), those with previous coronary artery bypass grafting (CABG), those with advanced chronic obstructive pulmonary disease, those who developed sepsis, and those with malignancy anamnesis. ACS was diagnosed based on an increase or decrease in Troponin I, with at least one value above the 99th percentile of the upper reference limit, and accompanying ischemic symptoms (chest pain lasting longer than 20 minutes). The diagnosis also required significant ST segment or T wave changes, newly formed left bundle branch block on electrocardiography (ECG), formation of pathological Q waves, or new or presumed new loss of viable myocardium. Additionally, it was diagnosed by finding at least one intracoronary thrombus in imaging and angiography related to regional wall motion disorder. For STEMI, ST segment elevation on ECG was defined as ≥ 0.1mV in all leads in both sexes except V2-V3 from the point J in two consecutive leads, with ≥ 0.2mV in men aged 40 years or older, and ≥ 0.25mV in men younger than 40 years in V2-V3. For women, ST elevation was set at ≥ 0.15mV as suggested by the universal definition of myocardial infarction.[11] The age, gender, and risk factors for CAD (including diabetes mellitus (DM), hypertension (HT), smoking, and dyslipidemia) of the patients were recorded. Coronary artery lesions detected in the patinets' CAG were also recorded. A lesion with 50% or more stenosis in any coronary artery was considered significant. The analysis of CAG data and calculation of SS were performed retrospectively. Patients with coronary artery lesions causing more than 50% lumen narrowing in vessels larger than 1.5 mm in diameter were included in the study. The total SS was calculated by scoring each lesion separately.[5] The SS was determined using software that calculates lesion scores separately, with a coefficient based on the morphological features of the lesions (Syntax score calculator v2.02, www.syntaxscore.com). An SS of ≤ 22 points was classified as low, 23-32 as intermediate, and ≥ 32 as high SS.[12] the patients were categorized into three groups: low SS, intermediate SS, and high SS. Biochemical values were measured using the COBAS C-501 (Roche, Manheim, Germany) device. Blood samples were collected from the antecubital vein of each patient at admission and on the first morning after at least 12 hours of fasting, and the data were recorded. The TyG index was calculated using the formula Ln [fasting triglycerides (mg/dl) x fasting glucose (mg/dl)/2].[13]

Statistical Analysis

Data were analyzed using IBM SPSS V23. The conformity to the normal distribution was examined using the Shapiro-Wilk and Kolmogorov-Smirnov tests. The Mann-Whitney U test was used to compare the data that were not normally distributed in paired groups, while the Kruskal-Wallis test was used to compare the data that were not normally distributed in groups of three or more. Categorical data were compared using the Pearson Chi-Square test, and multiple comparisons were made using the Bonferroni Corrected Z test. Results were presented as mean ± standard deviation and median (minimum–maximum). The significance level was set as $p < 0.050$.

Results

The mean age of the study group was 63.15 ± 12.69 years, with 145 (67.8%) being male. Among the patients, 96 (44.9%) had a known history of CAD, 148 (69.2%) had HT, and 90 (42.1%) had DM. CAG revealed the presence of lesions in the left anterior descending artery (LAD) in 104 (48.6%) patients, the LAD lateral branch (diagonal) in 17 (8%), the circumflex artery (CX) in 70 (32.7%), the CX lateral branch (Obtus Marginal, OM) in 11 (5.2%), and the right coronary artery (RCA) in 91 (42.5%). Of the CAG results, 61 (28.5%) patients had normal coronary coronaries, 122 (57%) underwent PCI, and 31 (14.5%) received surgical treatment. The distribution os scores was as follows: 140 (65.4%) patients had low SS, 52 (24.3%), had intermediate SS, and 22 (10.3%) had high SS. The demographic, clinical, and laboratory characteristics of the patients are shown in Table 1.

The patients had a mean triglyceride level of 155.79 ± 109.69 mg/dL, a mean high density lipoprotein (HDL) level of 39.87 ± 22.25 mg/dL, a mean low density lipoprotein (LDL) level of 126.31 ± 47.27 mg/dL, and a mean total cholesterol level of 174.82 ± 45.66 mg/dL. The mean fasting blood glucose levels was 141.4 ± 75.98 mg/dL. The laboratory characteristics of the patients are shown in Table 2.

According to the results of CAG, there was no statistically significant difference in the median TyG index values among patients ($p = 0.635$). The median TyG index value for patients with normal CAG results was 7476, for those who underwent PCI was 8466.5, and for those who had CABG was 8525 (Table 3).

There was no statistically significant difference in the median TyG index values among patients based on the presence of lesions in the LAD after CAG ($p = 0.104$). The median TyG index value of the LAD diagonal side branch was 8084.5 for patients without lesions and 8893 for those with lesions. There was no statistically significant difference between the presence of lesions in the CX and the median TyG index values of the patients ($p = 0.160$). The median TyG index value was 8084.5 for CX-OM

Table 1 - Demographic, Clinical and Laboratory Characteristics of the Patients

	Frequency, n	Percentage, %
Gender		
Female	69	32.2
Male	145	67.8
CAD		
No	118	55.1
Yes	96	44.9
HT		
No	66	30.8
Yes	148	69.2
DM		
No	124	57.9
Yes	90	42.1
LAD		
Lesion (-)	110	51.4
Lesion (+)	104	48.6
LAD Diagonal		
Lesion (-)	196	92
Lesion (+)	17	8
CX		
Lesion (-)	144	67.3
Lesion (+)	70	32.7
CX-OM		
Lesion (-)	200	94.8
Lesion (+)	11	5.2
RCA		
Lesion (-)	123	57.5
Lesion (+)	91	42.5
Coronary imaging Results		
Normal	61	28.5
PCI	122	57
CABG decision	31	14.5
SYNTAX Scoring		
Low SS	140	65.4
Intermediate SS	52	24.3
High SS	22	10.3
	mean ± SD	median (min-max)
Age	63.15 ± 12.69	63 (25 - 90)

CAD: coronary artery disease; HT: hypertension; DM: diabetes mellitus; LAD: left anterior descending artery; CX: circumflex artery; OM: obtus marginalis: RCA: right coronary artery; SYNTAX: SYNergy between PCI with TAXUS.

Table 2 - Descriptive Statistics of Laboratory Parameters

	Mean ± SD	Median (min-max)
WBC (10^3/μL)	9.33 ± 3.8	8.6 (2 - 29.4)
Hg (g/dL)	13.98 ± 2.29	14.2 (7.6 - 18.9)
Plt (mm3)	251.38 ± 74.7	248.5 (3.1 - 600)
Troponin (ng/L)	3984.57 ± 6969.37	546.2 (2.5 - 25000)
Fasting blood glucose (mg/dL)	141.4 ± 75.98	113 (62 - 605)
Creatine (mg/dL)	2.03 ± 9.81	0.9 (0.5 - 104)
Albumin (g/L)	39.94 ± 6.58	41 (3.4 - 51)
Sodium (mmol/L)	139.05 ± 7.85	139 (40 - 164)
Potassium (mmol/L)	5.31 ± 13.18	4 (2.6 - 145)
Triglyceride (mg/dL)	155.79 ± 109.69	124 (40 - 1100)
HDL (mg/dL)	39.87 ± 22.25	36 (18.1 - 288)
LDL (mg/dL)	126.31 ± 47.27	122 (43 - 262)
Total Cholesterol (mg/dL)	174.82 ± 45.66	170 (64 - 285)

WBC: White blood cell; Hg: Hemoglobin; Plt: Platelet; HDL: High density lipoprotein; LDL: Low density lipoprotein; SD: standard deviation

Table 3 - Comparison of TyG Index Values According to CAG Results

	TyG Index			
CAG Result	Mean ± SD	Median (min-max)	TS	p
Normal	11061.18 ± 11939.07	7476 (1829 -68170)	0.908	0.635
PCI	11543.72 ± 12121.93	8466.5 (2240-97405)	0.908	0.635
CABG	11458.19 ± 8262.69	8525 (2653 - 31808)	0.908	0.635

PCI: Percutaneous coronary intervention; CABG: coronary artery bypass grafting; TS: Test Statistics; TyG: triglyceride-glucose; CAG: coronary angiography; SD: standard deviation.

without lesions and 8682 for those with lesions. There was no statistically significant difference regarding the presence of lesions in RCA and the median TyG index values of the patients (p = 0.242) (Table 4).

There was no statistically significant difference in the distribution of genders according to the SS system (p = 0.598). A statistically significant difference was found in the distribution of patients with CAD according to SD (p = 0.002), with the differences seen in the CAD rates between those with low SD and those with other scores. The CAD rate was 36.4% in patients with low SS, 57.7% in those with intermediate SS, and 68.2% in those with high SS. There was no significant difference between the distribution of patients with HT according to SS (p = 0.383). A statistically significant difference was found in the distribution of patients with DM according to SD (p = 0.022), with the difference seen in DM rates between those with low SS and intermediate SS. The DM rates was 35.7% in patients with low SS and 57.7% in those with intermediate SS (Table 5).

A statistically significant difference was found in the distribution of lesions in LAD according to SS (p < 0.001), with the difference seen in the rate of lesions between those with low SS and other scores. The rate of LAD lesions was 34.3% in patients with low SS, 71.2% in those

Table 4 - Comparison of Patients With Lesions in LAD and TyG Index

	TyG Index		TS	p
	Mean ± SD	Median (min-max)		
LAD				
Lesion (-)	11231.59 ± 11952.08	7544 (1829 - 68170)	4983	0.104
Lesion (+)	11565.34 ± 11153.52	8692.5 (2260 - 97405)		
LAD Diagonal				
Lesion (-)	10679.99 ± 10000.54	8084.5 (1829 - 97405)	---	---
Lesion (+)	20061.59 ± 21586.24	8893 (2575 - 68170)		
CX				
Lesion (-)	11401.36 ± 13067.89	7866.5 (1829 - 97405)	4443.5	0.160
Lesion (+)	11378.2 ± 7585.33	8700 (2240 - 31808)		
CX-OM				
Lesion (-)	11630.89 ± 11866	8084.5 (1829 - 97405)	---	---
Lesion (+)	8650.91 ± 4054.64	8682 (3913 - 17290)		
RCA				
Lesion (-)	11160.95 ± 12541.12	7670 (1829 - 97405)		
Lesion (+)	11708.49 ± 10102.99	8692 (2520 - 66495)	5073	0.242

LAD: left anterior descending artery; CX: circumflex artery; OM: obtus marginalis: RCA: right coronary artery; SD: standard deviation; TS: Test Statistics; TyG: triglyceride-glucose.

Table 5 - Comparison of the Distribution of Sex and Additional Diseases According to SS

	Low SS n (%)	Intermediate SS n (%)	High SS n (%)	TS	p
Gender					
Female	47 (33.6)	17 (32.7)	5 (22.7)	1.03	0.598
Male	93 (66.4)	35 (67.3)	17 (77.3)		
CAD					
No	89 (63.6)a	22 (42.3)b	7 (31.8)b	12.323	0.002
Yes	51 (36.4)a	30 (57.7)b	15 (68.2)b		
HT					
No	46 (32.9)	16 (30.8)	4 (18.2)	1.92	0.383
Yes	94 (67.1)	36 (69.2)	18 (81.8)		
DM					
No	90 (64.3)a	22 (42.3)b	12 (54.5)ab	7.632	0.022
Yes	50 (35.7)a	30 (57.7)b	10 (45.5)ab		

CAD: coronary artery disease; HT: hypertension; DM: diabetes mellitus; SS: SYNTAX score; Pearson Chi-Square; a-b: There is no difference between rates with the same letter; TS: Test Statistics with intermediate SS, and 86.4% in those with high SS. A statistically significant difference was found in the distribution of lesions in CX according to SS (p < 0.001), with the difference seen in the rate of lesions between those with low SS and other scores. The rate of CX lesions was 16.4% in patients with low SS, 59.6% in those with intermediate SS, and 72.7% in those with high SS. A statistically significant difference was found in the distribution of lesions in the RCA according to SS (p = 0.001), with the difference seen in the rate lesions between those with low SS and high SS. The rate of RCA lesions was 35% in patients with low SS and 77.3% in those with high SS (Table 6).

There was no statistically significant difference in the median TyG index values according to the SS groups (p = 0.312). The median TyG index value was 7892.5 in patients with low SS, 8875 in those with intermediate SS, and 7467.5 in those with high SS (Table 7).

Discussion

Cardiovascular diseases are among the leading causes of mortality and morbidity worldwide, with approximately 17.9 million deaths annually due to these conditions.[14] Although advances in treatments and improvements in intensive care unit features and equipment have helped reduce mortality, especially in developed nations, increasing life expectancy and the prevalence of HT, diabetes, and obesity will ensure that cardiovascular diseases continue to a significant concern in the future.[15] Among the cardiovascular diseases group, ischemic heart diseases, especially ACS, are of particular concern due to their high mortality rates.[16] Given the high mortality and morbidity rates in ACS patients, it has become important to identify the high-risk group before cardiac events occur, leading to the development of various risk SS.[17] CAG is the gold standard method for determining the severity of CAD in patients presenting with ACS. It also aids in treatment decisions. For this reason, some SS based on angiography images have been developed. The SS is one such system used to rate the anatomical severity of CAD.[6] It is known that calculating SS and interpretating it regarding PCI or surgery will contribute to the patient in terms of mortality and morbidity, especially in patient groups with diabetes, left main coronary disease, or multi-vessel disease.[18]

Table 6 - Comparison of the Distribution of Lesions in the Heart Vessels According to SS

	Low SS	Intermediate SS	High SS	TS	p
LAD					
Lesion (-)	92 (65.7)a	15 (28.8)b	3 (13.6)b	34.632	<0.001
Lesion (+)	48 (34.3)a	37 (71.2)b	19 (86.4)b		
LAD Diagonal					
Lesion (-)	130 (92.9)	46 (90.2)	20 (90.9)	---	---
Lesion (+)	10 (7.1)	5 (9.8)	2 (9.1)		
CX					
Lesion (-)	117 (83.6)a	21 (40.4)b	6 (27.3)b	49.969	<0.001
Lesion (+)	23 (16.4)a	31 (59.6)b	16 (72.7)b		
CX-OM					
Lesion (-)	134 (96.4)	48 (96)	18 (81.8)	---	---
Lesion (+)	5 (3.6)	2 (4)	4 (18.2)		
RCA					
Lesion (-)	91 (65)a	27 (51.9)ab	5 (22.7)b	14.768	0.001
Lesion (+)	49 (35)a	25 (48.1)ab	17 (77.3)b		

Pearson Chi-Square; a-b: There is no difference between odds with the same letter; frequency (percent) TI: Test Statistic.
NOTE: Since LAD diagonal and CX-OM distributions are not suitable for comparison, no comparison has been made. LAD: left anterior descending artery; CX: circumflex artery; OM: obtus marginalis: RCA: right coronary artery; SS: SYNTAX score; TS: Test Statistics.

Table 7 - Comparison of TyG Index Values According to SS

	TyG Index		TS	P
SYNTAX Score	Mean. ± SD	Median (min-max)		
Low SS	11324.81 ± 12596.66	7892.5 (1829 - 97405)	2.332	0.312
Intermediate SS	12678.69 ± 10320.71	8875 (2240 - 51150)		
High SS	8795.68 ± 5634.96	7467.5 (3022 - 24585)		

Kruskal Wallis Test; Mean ± Standard deviation, Median (minimum-maximum) TS: Test Statistic; TyG: triglyceride-glucose; TS: Test Statistics; SD: standard deviation; SYNTAX: SYNergy between PCI with TAXUS; SS: SYNTAX score.

Although many studies have shown an association between the SS and poor outcomes in patients with ACS, to the best of our knowledge, none have examined the association between SS and the TyG index. While many parameters have been compared with SS, there is no study in the literature comparing the TyG index and SS. In our study, we aimed to investigate the relationship between SS categories (low, intermediate, and high) and TyG index.

One study showed that different ventricular remodeling patterns are associated with SS in hypertensive patients; however, the exact relationship between ischemic remodeling and SS remained unclear.[19] SS has been associated with poor clinical and angiographic outcomes after primary percutaneous intervention.[20] In addition, major adverse cardiac events have been found to be associated with SS not only in patients with ACS but also in patients with stable angina pectoris.[21,22] A recent study showed an association between the extent of CAD assessed by SS and novel markers of inflammation. The complex relationship between clinical outcomes and SS awaits further clarification.[23] Although SS is an angiographic SS, it rather reflects an ultimate measure of the complex atherosclerotic process. In our study, a significant difference was found between lesions in the coronary vessels and the SS system ($p < 0.05$). A statistically significant difference was also found, especially between those with a diagnosis of CAD and DM and the SS system (CAD [$p = 0.002$], DM [$p = 0.022$]). Due to the current significant statistically significant relationship between DM and SS, the relationship between TyG and SS was investigated.

TyG index is a biomarker that can be calculated from routine biochemistry tests and can provide indirect information about insulin resistance. In many studies, the relationship of a high TyG index with the presence, severity and prognosis of CAD has been revealed. In a study that included 791 patients with of ACS and followed up for 12 months, it was shown that a high TyG index was a risk factor for the development of major cardiovascular events.[24] We did not follow up on our patients for 12 months in our study. In our study, we investigated the relationship between low, intermediate, and high SS and TyG index. We could not find a statistically significant relationship between the SS system and TyG. In another study including 2840 patients, CAD was found to be associated with the TyG index.[25] In our study, while there was no significant difference in the TyG index in patients with CAD and HT, the TyG index of patients with DM was statistically significant. We think that the possible reasons for the lack of significant difference in our study may be the relatively small sample size and the fact that the patient population was collected from the same region.

The limitations of our study are that it was conducted in a single center, the number of patients was small, and patients with USAP and stable angina pectoris were not included in the study. To address these limitations, multicenter studies are needed in larger patient populations.

Conclusion

This study showed that there is a significant relationship between the SYNTAX SS and DM patients, no statistically significant relationship was found between the TyG index and the SS system, and in this context, more patients and more studies are needed.

Author Contributions

Conception and design of the research and writing of the manuscript: Özmen M, Ardahanlı İ; acquisition of data: Özmen M, Arikan E, Ozel F, Ardahanlı İ; analysis and interpretation of the data and critical revision of the manuscript for intellectual content: Özmen M, Ozel F, Ardahanlı İ; statistical analysis: Özmen M, Arikan E, Ardahanlı İ.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any thesis or dissertation work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Erzurum Regional Training and Research Hospital under the protocol number 2022/6-48. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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