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Triglycerides/High Density Lipoprotein-Cholesterol Ratio as a Novel Marker of Atherosclerosis in Patients with Acute Coronary Syndrome

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Abstract

Background: A high Triglycerides/High Density Lipoprotein-Cholesterol (TG/HDL-C) ratio was considered a cardiovascular disease and mortality risk factor. **Aim**: to assess the use TG/HDL-C ratio as potential new measure of atherosclerosis in ACS. **Methods**: This cross-sectional study included 200 ACS patients subjected to clinical &laboratory assessment, (CK-MB), high-sensitive troponin, lipogram, (eGFR), (ECG) & Echocardiography. TGs /HDL-C ratio will be calculated. **Results**: This study included 200 patients separated into 3 groups: (Group A: n= 24 patients with unstable angina; Group B: n=124 patients with STEMI and Group C: n= 52 patients with NSTEMI). Regarding the mean TG/HDL-C ratio, was 4.44± 3.26. Most cases (85.5%) had high ratio. There is non-significant differences between 3 groups regarding TG /HDL-c ratio ($p>0.05$). **Conclusion:** There was a strong correlation between high TG /HDL-c ratio & the pattern of ACS. Therefore, TG to HDL-C ratio may be used as a biomarker of atherosclerosis in ACS patients.

Keywords: Acute Coronary Syndrome, Triglycerides, HDL-cholesterol, Atherosclerosis.

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Introduction

Acute coronary syndrome, often known as ACS, is a prevalent kind of death that is responsible for millions of deaths all over the world [1].

The clinical manifestations of ST-segment elevation myocardial infarction (STEMI), unstable angina (UA), & non-ST-segment elevation myocardial infarction (NSTEMI) are all included in this category [2].

Acute myocardial infarction (AMI) is a complex etiology that involves several variables; however, a lipid metabolism abnormality has been linked in multiple studies to the condition [3].

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A more convenient & user-friendly atherogenic measure is the ratio of triglycerides to high density lipoprotein cholesterol (TG/HDL-C) [4].

A high blood triglyceride-to-high-density lipoprotein cholesterol ratio has been linked to a raised risk of coronary artery disease & death in the general population [5].

Increasing evidence suggests that the (TG/HDL-C) is a useful as well as easy indication of insulin resistance as well as metabolic syndrome [6,7].

The goal of this research was to examine the ratio of triglycerides to high density lipoprotein cholesterol among individuals with ACS to identify a potential new marker of atherosclerosis.

Patients & methods

Two hundred participants admitted to the Coronary Care Unit at Sohag University Hospitals with ACS during January 2022 and May 2023 were included in this cross-sectional study. Sohag University's Medical Faculty Ethical & Scientific Research Committees reviewed & approved the work. Everyone involved provided written informed consent.

Non-ST segment elevation myocardial infarction, ST-segment elevation myocardial infarction & Unstable angina are all examples of acute coronary syndromes [8]. Persons meeting the criteria for ACS (as defined by the most recent international consensus) & presenting to the hospital with cardiac chest discomfort included those with any of the following characteristics: Elevated cardiac enzymes or abnormalities on the electrocardiogram (ST elevation, ST depression, T wave inversion, or recent left bundle branch block) [9].

We excluded patients < 18 years old, with rheumatic heart disease (RHD) or congenital heart disease from this study.

All participants subjected to full history taking, clinical assessment, laboratory investigations, high-sensitive cardiac troponin, LDL-C, triglycerides, high-density lipoprotein cholesterol, Blood urea level, serum creatinine & (eGFR), Electrocardiogram and Echocardiography. Based on the values of the lipid profile TGs/HDL-C ratio will be calculated.

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According to the results of both ECG and cardiac enzymes patients had been classified into:

Unstable angina: When there is myocardial ischemia but no observable myocardial necrosis, we call it acute coronary syndrome, also known as unstable angina [10].

STEMI: Whenever transmural myocardial ischemia causes myocardial damage or necrosis; we speak of an acute ST-elevation myocardial infarction [11].

NSTEMI: The absence of ST segment elevation is used to define non-ST segment elevation myocardial infarction [12].

Statistical analysis:

The information was analyzed statistically using IBM's Statistical Package for the Social Sciences (IBM-SPSS) version 24 (May 2016). Numbers, percentages, the mean, & the standard deviation are all employed to describe the data. The quantitative information was determined using mean & standard deviation, whereas qualitative data was described using numbers as well as percentages. The following tests were done: Chi-Square test, Mann-Whitney U test, & Kruskal-Wallis H test. P value under 0.05 was considered significant.

Results

This trial conducted on 200 cases, their mean age was (51.96) years & ranged from 21 to 85 years; 154 (77%) were males, 130 (65%) were diabetic, 69 (34.5%) were hypertensive, 102 (51%) were current smokers, 28 (14%) had family history of cardiac disease and 19 (9.5 %) had prior history of PCI or CABG. participants were categorized into 3 groups: (Group A: n= 24 "12%", cases with unstable angina; Group B: n=124 "62%", patients with STEMI and Group C: n= 52 "26%", persons with NSTEMI) (Table 1). The three groups varied significantly in gender. (p=0.016) as female cases were higher in UA group while male cases were higher in both STEMI and NSTENMI groups. Age was not significantly distinct amongst each of the groups (p>0.05).

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Table (1): Distribution of studied cases as regards demographic characteristics:

Parameters		Studied cases (N= 200)	
		N	%
• Gender	Male	154	77.0%
	Female	46	23.0%
• Age group	18- 30 years	5	2.5%
	31- 40 years	55	27.5%
	41- 50 years	36	18.0%
	51- 60 years	50	25.0%
	> 60 years	54	27.0%
• Age (years)	Mean± SD	51.96± 13.85	
	Median	52.0	
	Range	21.0 – 85.0	

SD= standard deviation, n: number, %: percentage,

Regarding risk factors, there was significant change among the three studied groups regarding hypertension (p under 0.001) as UA group had higher cases with hypertension. The three groups vary significantly in prior PCI or CABG (p=0.022) In terms of diabetes, smoking habits, along with a history of cardiovascular disease in the family, there was not a significant distinction amongst both of the groups that were evaluated (p>0.05) (Table 2).

Table (2): Comparison amongest the studied groups as regards risk factors:

Parameters		UA group (N= 24)		STEMI group (N= 124)		NSTEMI group (N= 52)		Chi- Square test	
		N	%	N	%	N	%	Test value	P- value
• DM	No	15	62.5%	86	69.4%	29	55.8%	3.047	0.218
	Yes	9	37.5%	38	30.6%	23	44.2%		
• HTN	No	6	25.0%	92	74.2%	33	63.5%	21.66	**<0.001**
	Yes	18	75.0%	32	25.8%	19	36.5%		
• Smoking status	Current smoker	7	29.2%	71	57.3%	24	46.2%	7.152	0.128
	Ex -smoker	5	20.8%	14	11.3%	7	13.5%		
	Not smoker	12	50.0%	39	31.5%	21	40.4%		
• Family history of cardiac disease	No	22	91.7%	108	87.1%	42	80.8%	1.946	0.378
	Yes	2	8.3%	16	12.9%	10	19.2%		
• Prior PCI or CABG	No	18	75.0%	115	92.7%	48	92.3%	7.629	**0.022**
	Yes	6	25.0%	9	7.3%	4	7.7%		

P value under 0.05 is significant, P value below 0.01 is highly significant, X^2= Chi- Square test,

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In terms of vital indicators like systolic blood pressure, diastolic blood pressure & pulse, there was not a statistically distinction among the three groups that were tested. In addition, there was no significant variation in vital signs among the three groups that were evaluated, including chest examination and lower limb measurements (p>0.05) (Table 3).

Table (3): Comparison among the studied groups as regards clinical examination:

Parameters		UA group (N= 24)		STEMI group (N= 124)		NSTEMI group (N= 52)			
		Mean	SD	Mean	SD	Mean	SD	Test value (KW)	P-value
• SBP (mm/Hg)		127.9	15.6	123.5	18.9	125.6	19.5	1.293	0.524
• DBP (mm/Hg)		80.4	10.8	79.4	11.7	80.4	13.1	0.181	0.914
• Pulse (beats/min.)		91.0	18.9	86.0	17.2	85.1	14.9	1.487	0.475
Chest examination	Fine basal crepitation	2	8.3%	10	8.1%	9	17.3%	4.367	0.359
	Clear	22	91.7%	110	88.7%	42	80.8%		
	Coarse crepitation	0	0.0%	4	3.2%	1	1.9%		
Lower limb edema	No	23	95.8%	118	95.2%	47	90.4%	1.645	0.439
	Yes	1	4.2%	6	4.8%	5	9.6%		

KW = Kruskal Wallis Test

Table (4) indicated echocardiography findings in the three studied groups. There was high statistically significant change amongst the three studied groups regarding segmental wall-motion abnormalities of the left ventricle (SWMA) (p<0.001). In terms of diastolic dysfunction, they differed highly significantly from one another (p=0.005) while there was high statistically significant distinction among them regarding impaired systolic function (p>0.05). The ejection fraction indicated a statistically significant disparity among the three studied groups (p=0.021) as it was significantly lower in STEMI group compared to NSTEMI group.

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Table (4): Comparison amongst the studied groups as regards echocardiography findings:

Parameters		UA group (N= 24)		STEMI group (N= 124)		NSTEMI group (N= 52)		Test value	p-value
		N	%	N	%	N	%		
• SWMA	No	11	45.8%	0	0.0%	11	21.2%	X^2=50.5	**<0.001**
	Yes	13	54.2%	124	100.0%	41	78.8%		
• Diastolic dysfunction	No	19	79.2%	120	96.8%	48	92.3%	X^2= 10.42	**0.005**
	Yes	5	20.8%	4	3.2%	4	7.7%		
• Impaired systolic function	Normal	21	87.5%	107	86.3%	50	96.2%	X^2= 4.329	0.363
	Fair	1	4.2%	7	5.6%	0	0.0%		
	Impaired	2	8.3%	10	8.1%	2	3.8%		
• EF (%)	Mean± SD	51.52± 10.8		47.48± 8.82		50.92± 10.49		*KW* = 7.725	**0.021**
	Median	55.0		47.0		53.0			
	Range	33.0 – 67.0		32.0 – 72.0		23.0 – 67.0			

Regarding laboratory results, neither group differed significantly from the other regarding renal function tests including serum creatinine, urea and eGFR (p>0.05). Significant variation existed among the three groups regarding cholesterol (p=0.045) as it was significantly higher in STEMI group when compared to UA group. Notable significant distinctions emerged among the three groups examined regarding LDL-C (p=0.011) as it was significantly higher in STEMI group when comparing with UA group. The groups that were studied did not vary significantly from one another regarding HDL-C, TG, & VLDL-C (p>0.05) (Table 5).

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Table (5): Comparison between the studied groups as regards renal function tests:

Parameters	UA group (N= 24)		STEMI group (N= 124)		NSTEMI group (N= 52)		Kruskal Wallis Test	
	Mean	SD	Mean	SD	Mean	SD	Test value	P-value
Creatinine	1.15	0.96	1.16	0.66	1.68	2.04	0.995	0.608
Urea	34.17	19.17	35.08	19.6	47.06	42.55	0.468	0.791
eGFR	116.50	47.35	110.66	47.1	102.51	50.36	0.560	0.756
TG (mg/dl)	134.13	50.77	155.13	74.77	161.32	120.27	1.248	0.536
TC (mg/dl)	171.68	49.04	192.14	44.21	186.83	69.56	6.182	**0.045**
HDL-C (mg/dl)	44.35	26.06	38.47	13.92	39.29	11.91	1.682	0.431

Regarding TG/HDL-C ratio, it ranged from 1.1 to 33 with mean (±SD) was 4.44± 3.26. Most cases (85.5%) had high ratio. By comparing TG /HDL ratio related to diagnosis. It was noticed non-significant differences between NSTEMI, STEMI and UA regarding TG/HDL-C as shown in table (6).

Table (6): TG /HDL ratio according to diagnosis:

Parameters		TG /HDL ratio					Kruskal Wallis Test	
		Mean	SD	Median	Range		Test value	p-value
• **Groups**	**NSTEMI**	4.525	4.481		1.30	33.0	1.699	0.428
	STEMI	4.559	2.868		1.10	16.0		
	UA	3.603	1.590		1.44	7.0		

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Discussion

Coronary heart disease is a growing global public health issue & the leading cause of death around the world. Prevention & medical attention of CHD are greatly aided by early risk stratification [13].

Furthermore, **Chen et al.** [14] noticed that the prevalence of atherosclerotic cardiovascular events was nearly 1.5-fold higher in the highest tertile of triglycerides/HDL ratio compared to the lowest ratio of triglycerides to high density lipoprotein cholesterol tertile in the general population.

Additionally, **Sultani et al.** [15] demonstrated that a ratio of triglycerides to HDL-C ratio at least 2.5 was related with approximately a three-fold rise in cardiovascular events over a five-year follow-up in high-risk individuals, regardless of traditional coronary risk factors as well as angiographic CAD severity.

Jeppesen et al. [16] has previously been shown that the triglyceride-to-high-density lipoprotein ratio is an independent predictor of cardiovascular mortality & CHD risk. According to other research, the ratio of triglycerides to HDL-C is a strong predictor of metabolic syndrome, vascular change, as well as insulin resistance [17].

Using a case-control design, **Gaziano et al.** [18] observed that an increased triglyceride-to-HDL-C ratio strongly predicted the risk of myocardial infarction. The high triglyceride/HDL-C ratio has been shown in a raised number of trials to be an excellent independent predictor of mortality/major adverse cardiac events in cardiovascular disease [14,15].

According to our results, regarding ratio of triglycerides to HDL-C, it varied from 1.1 to 33 with mean (±SD) was 4.44± 3.26. most cases (85.5%) had high ratio. As regard lipid profile performed in the studied cases. The mean TG and cholesterol were 154.22± 86.73 mg/dl and 188.31± 52.62 mg/dl respectively. The mean HDL and LDL was 39.39± 15.43 mg/dl and 119.87± 48.72 mg/dl respectively while the mean VLDL was 31.24± 17.6 mg/dl.

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Similarly with our results, **Wan et al.** [19] indicated that TG/ HDL-C ratio 3.39±1.67 in persons with high ratio of triglycerides to high density lipoprotein cholesterol & the mean HDL was 42.15 ± 18.95, LDL was 100.15 ± 38.67, and TG was 318.87 ± 168.29.

Also, **Islam et al.** [20] identified that the one hundred participants were comprised of fifty individuals with illness (cases) and 50 healthy people (controls), as well as discovered that the TG/HDL ratio in cases was 4.2±1.7, along with the mean level of TG in cases was 168.2±88.0 in contrast to HDL 41.3±5.1.

Additionally, **Luz et al.** [21] investigated There were 220 men & 154 women among the participants in the present research, age 57.2 ± 11.1 years, with TC of 210 ± 50.3 mg/dl, TG of 173.8 ± 169.8 mg/dL, HDL-C of 40.1 ± 12.8 mg/dl, LDL-C of 137.3 ± 46.2 mg/dl, ratio of triglycerides to high density lipoprotein cholesterol of 5.1 ± 5.3.

Our results finding that, most cases (61%) had ST- segment elevation. LBBB was found in 12% cases, ST segment depression in 10.5% cases, deep inverted T wave and pathological Q wave in 4.5% cases, biphasic T wave in 4% cases and inverted T wave in 3.5% cases. That came in similar to **Achar et al.** [22].

In agreement with our results, The ratio of triglycerides to high density lipoprotein cholesterol proved to have the strongest associated with coronary disease severity after being included in a multivariate analysis by logistic regression involving these lipid variables. The degree of the disease was reduced by twenty-two percent with every quartile rise in HDL-c, but increased by twenty-three & thirty percent, respectively, for every quartile increase in LDL-c and ratio of triglycerides to high density lipoprotein cholesterol [21].

Consistent with these trials, we discovered that the prevalence of cardiovascular events among those with suspected CAD was doubled in the highest tertile of the ratio of triglycerides to high density lipoprotein cholesterol ratio (above 2.66), even after controlling for established risk variables.

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According to the American Heart Association's most recent guideline for the evaluation & diagnosis of chest pain, CCTA is useful for visualizing & diagnosing atherosclerotic plaque composition and high-risk characteristics, as well as the presence and severity of nonobstructive & obstructive CAD. CCTA is useful for diagnosing CAD, stratifying risk, and guiding treatment decisions in intermediate-high-risk individuals who have stable chest discomfort and no known CAD [23].

Conclusion

Triglycerides to high-density lipoprotein cholesterol ratios were strongly related with main CAD risk variables in this investigation. This study found that high-risk atheromatous plaques in ACS were substantially linked with TG/high density lipoprotein cholesterol ratio increases. Triglycerides to high density lipoprotein cholesterol ratio may be a biomarker for Acute Coronary Syndrome individuals' atherosclerosis.

Authorship contributions

Mohamed H. El-Rashidy: acted as a guarantee and corresponding author, he contributed mainly for Conception and design of the study, interpretation of data & final approval of the manuscript

Usama A. Arafa: Contributed to study design data acquisition and analysis.

Nayel A. Zaki: Contributed to the data acquisition and analysis and edited a major part of the manuscript.

Fatma M. Ahmed: participated in writing, manuscript preparation, Conception and design of the study, interpretation of data &final approval of the manuscript.

Conflict of Interest:

The authors declare that they have no competing interests.

Funding statements

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Data availability statement:

The data that support the findings of this study are available from corresponding author upon reasonable request.

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