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Safa Mohammed Hassan

Department of Pharmaceutical Science, Al Sader Medical City, Ministry of Health, Iraq,
Safam.alhakeem@student.uokufa.edu.iq

Rawaa Hadi Shareef

Department of Pharmacology & Toxicology, Faculty of Pharmacy, University of Kufa, Iraq,
Rawaah.alsaabary@uokufa.edu.iq

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ORIGINAL STUDY

Evaluation of Triglyceride/High Density Lipoprotein Ratio as a Diagnostic and Prognostic Marker for Reduced Ejection Fraction Heart Failure in Comparison to Brain-Natriuretic Peptide

Safa Mohammed Hassan ^a, Rawaa Hadi Shareef ^{b,*}

^a Department of Pharmaceutical Science, Al Sader Medical City, Ministry of Health, Iraq

^b Department of Pharmacology & Toxicology, Faculty of Pharmacy, University of Kufa, Iraq

Abstract

Background: heart failure is a condition that heart cannot pump blood in efficient way and this result in building up fluid and a reduced supply of oxygen to organs. Also, it can result from conditions like heart disease, hypertension, or diabetes. Brain natriuretic peptide (BNP) can be used in the diagnosis and evaluation of heart failure severity. The triglycerides-to-HDL ratio is a key marker of cardiovascular risk in heart failure, reflecting insulin resistance and metabolic health. A high ratio is associated with worse outcomes, including increased inflammation and arterial stiffness.

Objectives: To evaluate the diagnostic and prognostic value of Triglyceride to HDL ratio for reduced ejection fraction heart failure in comparison with brain-natriuretic peptide.

Methods: A case-control study was carried out between October 2024 and March 2025 at an internal medicine specialist in Al-Najaf, Iraq. There were 180 participants, 90 as control group and 90 as heart failure patients. The information gathered comprised height, weight, age, gender, brain natriuretic peptide (BNP), triglyceride (TG) and high-density lipoprotein (HDL).

Results: The results showed that when comparing BMI, age, and gender between cases and control groups there was no significant difference ($P > 0.05$). While, there was a significant variation in the levels of BNP and TG/HDL ratio between them ($P < 0.000$). According to the results, the sensitivity and specificity of BNP and TGL/HDL ratio as diagnostic & predictive markers were approximate. Additionally, a positive & significant correlation between TG/HDL ratio and inflammatory marker C-reactive protein was observed.

Conclusion: BNP and TG/HDL ratio are significant factors that play an important role in heart failure, TG/HDL ratio can be used as a diagnostic and predictive marker in heart failure reflect association between dyslipidemia, inflammation, and heart failure.

Keywords: Heart failure disease, Dyslipidemia, Inflammation, Brain natriuretic peptide, Triglyceride/HDL ratio

1. Introduction

Heart failure is a clinical condition and serves as a marker indicative of underlying pathophysiological mechanism and left ventricular ejection fraction (LVEF) is generally a clinically useful phenotypic

[1]. The high rates of death, morbidity, poor functional ability and quality of life are continuously linked to HF. Depending on the various etiologies and clinical traits seen in HF patients, the regional variances exhibit by the reported incidence, prevalence morbidity and mortality rates [2]. Although the age-adjusted

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* Corresponding author.

E-mail addresses: Safam.alhakeem@student.uokufa.edu.iq (S. M. Hassan), Rawaah.alsaabary@uokufa.edu.iq (R. H. Shareef).

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incidence of heart failure may be declining in affluent nations, perhaps as a result of improved cardiovascular disease management, the overall incidence is rising as people age [3]. Heart Failure Collaboratory, and Academic Research Consortium proposed the following definitions and EF ranges as their most recent recommendations: HF with reduced EF (HFrEF): HF with left ventricular ejection fraction (LVEF) $\leq$ 40%. HF with preserved EF: HF with LVEF $>$ 50%. HF with mid-range EF (HFmrEF): HF with LVEF $>$ 40% and LVEF $<$ 50% [4]. Natriuretic peptides are endogenous peptide hormones, which are released from the heart chambers in response of cardiomyocytes to myocardial stretch due to volume or pressure overload. They promote vasodilation and natriuresis, so the atrial/ventricular filling decreases, and the subsequent reduction in preload reverses, or result in slow down the remodeling of the cardiac [5]. Serum levels of BNP and NT-proBNP have recently been utilized as criteria for patient enrollment in studies assessing the effectiveness of treatment approaches for heart failure [6]. Dyslipidemia is considered as a modifiable risk factor for CVDs [7]. The lipid profile such as, HDL, LDL, triglycerides and non-HDL cholesterol, is routinely assessed to assess a cardiovascular risk [8]. Many comorbidities that are common in patients with HF and have negative effect on clinical outcomes like hypertension, type 2 diabetes, obesity, dyslipidemia, and metabolic syndrome [9]. High levels of serum triglycerides or lower HDL are directly associated with damage of endothelial and atherosclerosis. So, the understanding the triglyceride/HDL cholesterol ratio as positively correlated with the severity of heart failure is not difficulty [10]. The increased TG levels which are one component of TG/HDL ratio may associated with the development of many risk factors for HF like, atherosclerosis and coronary artery disease [11]. The HDL has the ability to prevent HF due to its anti-diabetic & anti-inflammatory properties [12].

The aim of this study was to evaluate diagnostic and prognostic value of Triglyceride to HDL ratio for heart failure with reduced ejection fraction in comparison to brain-natriuretic peptide.

2. Materials and methods

2.1. Study design and patients

The design was a case-control study conducted by an internal medicine specialist in Al-Najaf City, Iraq, from October 2024 to March 2025. There were 180 individuals in total, 90 of whom were heart failure patients (42 men and 48 women) and 90 of whom were control group members (40 men and 50 women).

People in the age range of (42 to 85). Essential data, including age, gender, family history, length of illness, medication history, blood pressure, and body mass index (BMI) of the participants. Serum samples were collected to evaluate brain natriuretic peptide and lipid profile (Triglyceride and HDL).

The following diagnostic kits were used in this study; kit of BNP (Eledere/China), Kit of HDL cholesterol (Spinreact/Spain), Kit of Triglycerides (Spinreact/Spain), ELISA Human/Germany (Eledere/China), Spin 200/automated analyzer (Spinreact/Spain).

2.2. Statistical analysis:

The statistical package for social sciences (SPSS) software (version 25 IBM SPSS, Inc., Chicago, Illinois, USA) and Microsoft Excel 2019 were used to analyze all of the data. The independent-test was used to compare numerical variables distributed customarily across the groups. All of the data was reported as the mean plus or minus the standard deviation. The graphical representation of nominal variables included both frequency and percentages (%). The study of the correlation coefficient was completed utilizing Pearson's Eta square. The significance of differences was detected at $P < 0.05$.

2.3. Ethical considerations

According to the ethical guidelines derived from the Declaration of Helsinki, the study was carried out. The patients' verbal and analytical consent was obtained before the sample was collected. The permission form, subject data, and study protocol were examined and approved by a local ethics committee in October 2024 in accordance with document number 82.

3. Results

The results of this study showed that there was no significant difference ($P > 0.05$) between cases group and control groups in gender distribution, as in Table 1, and according to results of Table 2, there was no discernible difference in age or BMI between cases and controls ($P > 0.05$).

Table 1. Distribution of the study population according to gender.

Gender	Patients	Control	P value
	Frequency + percent	Frequency + percent	
Male	42 (46.7%)	40 (44.4%)	0.83
Female	48 (53.7%)	50 (55.6%)	
Total	90 (100%)	90 (100%)	

Table 2. Distribution of study population according to age and BMI.

Variables	Mean $\pm$ S.D of patients	Mean $\pm$ S.D of controls	P value
Age	66.9 $\pm$ 12	64.7 $\pm$ 10.5	0.69
BMI	29.0 $\pm$ 5	28.25 $\pm$ 4.5	0.14

Additionally, the study found that there was a significant difference ($P < 0.05$) in the levels of BNP, Triglyceride, HDL, and TG/HDL ratio in HF patients and controls, when comparing them as in Table 3, and BNP was occurred a good diagnostic and predictive test for patients; its area under the curve was 0.87 (Table 4), its sensitivity was 85.6%, with 75.6% as specificity. BNP's sensitivity is 85.6%. that means approximately 86% of patients who receive a BNP diagnosis of heart failure have heart failure. While BNP's specificity is 75.6%, meaning that roughly 76% of those who receive a BNP diagnosis of normal are diagnosed as normal. as seen in Table 5 and Fig. 1.

On the other hand, TG/HDL also can be considered as a good diagnostic & predictive test in the patients' group because it had a good Area under curve is 0.882 (Table 6) with sensitivity 83.3% and specificity as 72.2% as in Table 7 & Fig. 2. Finally, there was a positive and significant correlation between CRP& TG/HDL ratio as shown in Fig. 3.

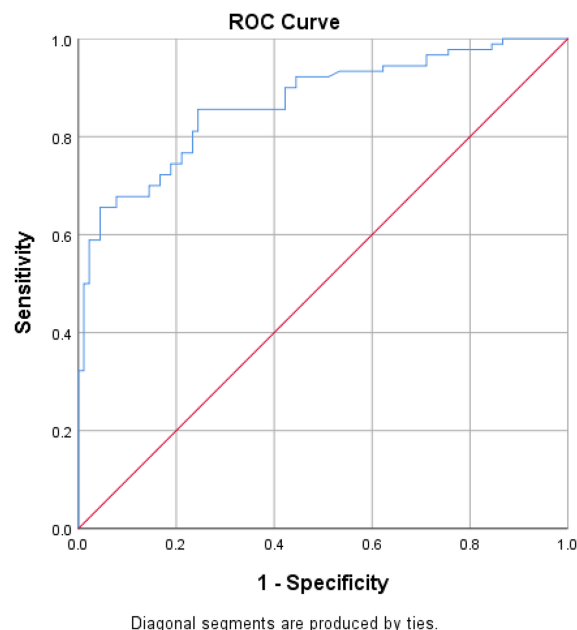


Fig. 1. ROC (Sensitivity * specificity) of BNP.

4. Discussion

The results of the study showed no significant differences in the distribution of gender and age between

Table 3. Levels of BNP, Triglyceride, HDL and TG/HDL ratio in heart failure patients & control groups.

Variables	Mean $\pm$ S.D of patients	Mean $\pm$ S.D of controls	P value
Triglyceride mg/dL	174.02 $\pm$ 74.3	138.46 $\pm$ 67.2	0.001
HDL mg/dL	30.85 $\pm$ 10.4	38.89 $\pm$ 10.4	0
TG/HDL ratio	6.4 $\pm$ 3.7	3.81 $\pm$ 2.2	0
Brain-natriuretic peptide (BNP)	114.62 $\pm$ 40.1	75.73 $\pm$ 36.7	0

SD = standard deviation, *Significant differences at P value < 0.05

Table 4. Area under curve AUC of BNP.

Test Result Variable(s): BNP			Asymptotic 95% Confidence Interval	
Area	Std. Error ^a	Asymptotic Sig. ^b	Lower Bound	Upper Bound
.870	.026	.000*	.818	.922

Table 5. (Sensitivity * Specificity) of BNP.

BNP	Disease		Total
	Negative	positive	
Negative			
Count	68	13	81
%Within disease	75.6% (specificity)	14.4%	45.0%
Positive			
Count	22	77	99
%Within disease	24.4%	85.6% (sensitivity)	55.0%
Total			
Count	90	90	180
% Within disease	100%	100%	100%

Table 6. Area under curve AUC of TG/HDL ratio.

Test Result Variable(s): TG/HDL ratio				
Asymptotic 95% Confidence Interval				
Area	Std. Error ^a	Asymptotic Sig. ^b	Lower Bound	Upper Bound
.882	.024	.000	.836	.929

Table 7. (Sensitivity * specificity) of TG/HDL ratio.

TG/HDL ratio	Disease		Total
	Negative	positive	
Negative			
Count	65	15	80
% within disease	72.2% (specificity)	16.7%	44.4%
Positive			
Count	25	75	100
% within disease	27.8%	83.3% (sensitivity)	55.6%
Total			
Count	90	90	180
% within disease	100.0%	100.0%	100.0%

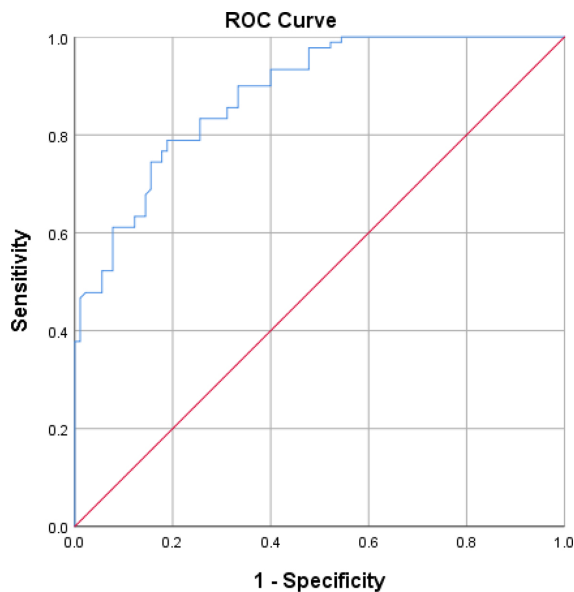
the study groups; this is related to the use of gender & age matching between these groups (case-control study). Also, the present study indicated a significant difference in BNP levels between control and heart failure patients. This increase in BNP value in heart failure patients may be due to the fact that in heart failure, there is a stretch in the ventricle wall and neurohormonal activation.

A study by Goetze et al., 2020 [13] showed that circulating BNP levels very low in a normal state, but it significantly increases in patients with HF as a mechanism for normal hemodynamics restoring.

The BNP had many effects like, anti-hypertrophic and anti-fibrotic effects, also it causes arterial vasodilation, diuresis, and natriuresis, counteracting the RAAS, SNS and endothelin systems activation. In routinely clinical practice, BNP is the most commonly used in the diagnosis, risk stratification, and clinical follow-up of patients with HF [14]. Many accumulating evidence suggests that in patients with chronic heart failure, the useful prognostic marker indicating admission & discharge from hospital is the higher secretion of BNP from overloaded left ventricles [15].

The results of the study showed, that there is a significant difference in the ratio of TG/HDL between control and heart failure patients (Table 3). This ratio may be serve as an indicator of lipid metabolism and insulin sensitivity in which both of them are crucial in pathogenesis of heart failure. Also, this ratio is important in predicting the presence and extent of coronary atherosclerosis which can cause heart failure over time. This is confirmed by Xing et al. [16] who found that the development of HF occurs through the effects of high insulin on cardiac function and damage to the myocardium directly by elevated TG and an elevated TG/HDL ratio.

Additionally, several studies have recognized that one of the important factors in predicting cardiovascular disease (CVD) occurrence is TG/HDL ratio [17]. Because of significant correlation of TG/HDL-C ratio, triglyceride in addition to glucose index (TyG) with hyper-insulinemic-euglycemic clamp results, these factors were suggested to be considered as a useful biomarker for IR identification. Additionally, these methods are more suitable for clinical practice [18]. The relation between insulin resistance and the



Diagonal segments are produced by ties.

Fig. 2. ROC (Sensitivity * specificity) of TG/HDL ratio.

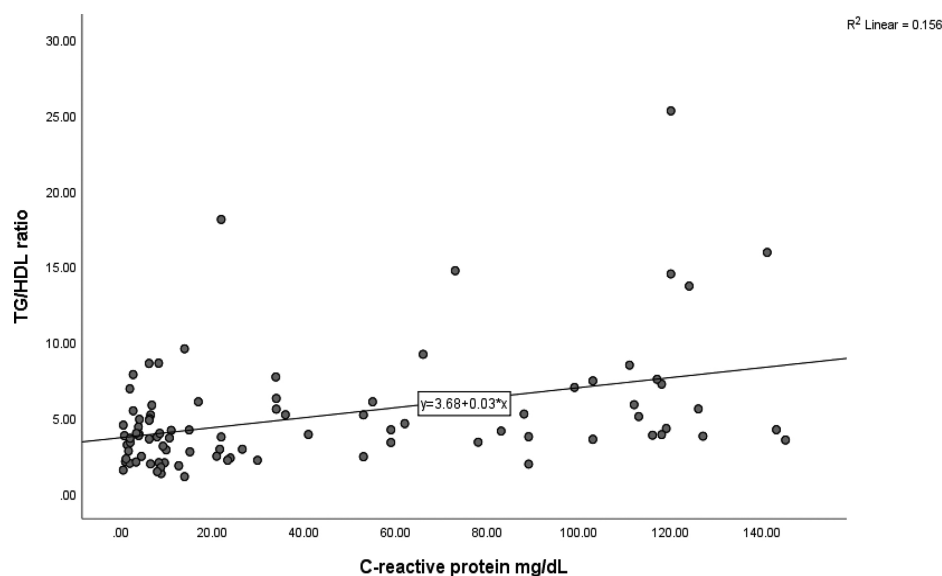


Fig. 3. correlation between CRP & TG/HDL ratio in heart failure patients.

development of heart failure disease correlated in close way, the insulin resistance is associated with nitric oxide inhibition, which had protection effect on vascular endothelium, that resulting in inappropriate renin–angiotensin system activation with low-grade inflammation systemically, so result in exacerbating of HF progression [19].

The TG/HDL ratio can be considered a sensitive marker for the development of HF as results of Table 7 & Fig. 2 and this is confirmed by Chang et al. [20] which found that HF incidence is associated with risk factor like high TG/HDL ratio.

According to the results of Fig. 3, there was a positive and significant correlation between CRP and TG/HDL ratio in heart failure patients. These positive correlations suggest a link between inflammation, metabolic dysfunction and dyslipidemia. Dyslipidemia and increased hs-CRP associated with CVD and abnormal lipid levels are often related to abnormal levels of inflammatory biomarkers including hs-CRP [21]. Accumulating evidence from recent studies indicates that serum lipids could accumulate in the heart, resulting in oxidative stress induction and inflammatory cardiac fibrosis, decreasing autophagy and microvascular density, and changing the mitochondrial function of cardiomyocytes, making the myocardium vulnerable to damage and leading to cardiac dysfunction and electrophysiological changes [22]. Finally, treatments for heart failure patients with reduced ejection fraction drug like sacubitril and valsartan combination had demonstrated clinical efficacy by improving vital signs related to the disease [23].

5. Conclusion

According to the results of the study, BNP and TG/HDL ratio play an important role in heart failure. The TG/HDL ratio can be used as predictive factor in heart failure disease, it reflects the association between dyslipidemia, inflammation & heart failure.

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The authors have no support to report.

Conflict of interest

The authors have declared that no competing interest exist.

Ethical considerations

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