Clinica Chimica Acta 485 (2018) 166–172

Contents lists available at ScienceDirect

Clinica Chimica Acta

journal homepage: www.elsevier.com/locate/cca

# Triglyceride to high density lipoprotein cholesterol ratio may serve as a useful predictor of major adverse coronary event in female revascularized ST-elevation myocardial infarction

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ARTICLE INFO

*Keywords:*
Triglyceride to high density lipoprotein cholesterol ratio
ST-elevation myocardial infarction
Prognosis
Major adverse coronary event

ABSTRACT

*Background:* Elevated triglyceride to high density lipoprotein cholesterol (TG/HDL-C) ratio has been identified as a surrogate marker of insulin resistance and an independent predictor for cardiovascular events in the general population. However, the prognostic value of TG/HDL-C ratio in revascularized ST-elevation myocardial infarction(STEMI) patients remains unclear. We examined the association between TG/HDL-C ratio and clinical outcome of revascularized STEMI patients in the Chinese population.
*Methods:* 464 STEMI patients who underwent successful revascularization were enrolled to determine the relationship between TG/HDL-C ratio and major adverse coronary events(MACEs) with a 30-month follow-up. The Kaplan-Meier analysis and Cox regression proportional hazard model were applied to assess the prognostic value of TG/HDL-C ratio.
*Results:* TG/HDL-C ratio was found to be significantly associated with age ($p = 0.017$), history of diabetes ($p = 0.017$), heart rate($p = 0.011$), TG($p < 0.001$), HDL-C($p < 0.001$) and Gensini score($p = 0.034$). The multivariate Cox regression analysis revealed that elevated TG/HDL-C ratio was an independent prognostic factor for MACE in female patients (HR = 2.624,95%CI = 1.211–5.687,$p = 0.014$) but not in male patients (HR = 0.756, 95%CI = 0.484–1.179,p = NS) after adjustment with other MACE-related prognostic factors.
*Conclusion:* The TG/HDL-C ratio may be independently associated with MACEs in female revascularized STEMI patients in the Chinese population.

## 1. Introduction

Dyslipidemia represented by the elevated triglycerides (TG), total cholesterol (TC) or decreased HDL cholesterol(HDL-C) levels and the predominance of small dense LDL(sd-LDL) particles is commonly presented in various cardiovascular diseases(CVDs) including ST-elevation myocardial infarction(STEMI) [1–3]. Recently, some novel parameters of lipid abnormality involved in insulin resistance, oxidative stress, inflammation, endothelial dysfunction, and increased thrombogenicity as well as plaque vulnerability have been documented [4–6], which was conferred an advantage at risk stratification in CVD compared to the traditional established risk factors such as individual TG, TC, LDL-C and HDL-C [7]. Typically, the triglyceride to high density lipoprotein cholesterol(TG/HDL-C) ratio, a known well-defined atherogenic dyslipidemia index, has been proposed to be a better indicator of insulin resistance [3, 8, 9], metabolic syndrome and coronary heart disease risk than other individual lipid profiles [3, 10–12]. Previous studies have also revealed that TG/HDL-C ratio can serve as a simpler and easily accessible marker in predicting the incidence of cardiometabolic and non-alcoholic liver diseases, diabetes, cardiovascular events and all-cause mortality [13–17]. Accumulating evidence supports the key pathophysiological role of TG/HDL-C ratio in the development of most CVDs and also demonstrates the prognostic significance of high TG/HDL-C ratio as an atherogenic lipid parameter in predicting adverse cardiovascular events and mortality of coronary heart disease or cardiovascular diseases [18], however, it remains largely unknown whether the TG/HDL-C ratio at admission is associated with the prognosis of STEMI following successful primary percutaneous coronary intervention(pPCI), and the fact that the clinical utility of TG/HDL-C ratio is complicated by variations in ethnicity and gender should not be overlooked as well [19, 20].

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https://doi.org/10.1016/j.cca.2018.06.049
Received 9 March 2018; Received in revised form 29 June 2018; Accepted 30 June 2018
Available online 30 June 2018

## 2. Materials and methods

### 2.1. Study design and population

The study population was derived from the public dataset provided by Yang et al. [21, 22], and the research ethic was no longer needed due to the public policy statement of the dataset which has also obtained the approval of research ethic in the previous study. In this retrospective study, all patients presented with onset symptoms of STEMI such as typical persistent chest pain (> 30 min) were initially retrieved and the diagnosis was further confirmed by prolonged ECG alteration such as ischaemic ST-segment elevation in two or more contiguous leads and/or depression, and obvious increases in serum myocardial enzyme and troponin concentrations. All the included patients received successful revascularization by pPCI within 24 h after onset of symptoms. Exclusion criteria included as following:1) non-STEMI; 2) severe vascular heart disease; 3) cardiogenic shock, previous onset of ventricular fibrillation, untreated third or advanced degree of atrioventricular block; 4) balloon angioplasty alone; 5) rescue PCI or conservative treatment without PCI; 6) secondary hypertension or endocrine diseases such as hyperthyroidism, adrenal cortical dysfunction; 7) cerebrovascular attack within 1 y or cerebrovascular attack with a significant residual neurological deficit; 8) chronic hepatitis or cirrhosis disease, or severe renal insufficiency; 9) with contraindication to statins, heparin, aspirin, clopidogrel, contrast or glycoprotein IIb/IIIa inhibitor(GPI); 10) malignancy; 11) estimated life expectancy < 12 months or other conditions; 12) recent serious infection, or connective tissue disease; 13) active severe bleeding or significant gastrointestinal or genitourinary bleeding; 14) major surgery or trauma within 6 weeks; (5) patients with incomplete clinical data. The flowchart of study participants selection process was illustrated in detail in the previous study [22].

### 2.2. Data collection

Standardized spreadsheet was used to collect information including age, gender, hypertension, diabetes, myocardial infarction and heart disease history, heart rate, blood pressure, culprit vessels, Killip's grade, stent number and Gensini score. The parameters of electrocardiogram, two-dimensional echocardiography and Doppler measured using standard methods were recorded. Laboratory parameters at admission under a fasting condition were also collected by trained investigators.

### 2.3. Definitions

The TG/HDL-C ratio was defined as the plasma TG concentration divided by the HDL-C concentration at admission. Plasma creatinine was used to estimate glomerular filtration rate(eGFR) according to the Modification of Diet in Renal Disease(MDRD) Study equation in participants from the Chinese centers: eGFR(ml/min per 1.73 $m^2$) $= 186 \times Pcr^{-1.154} \times age^{-0.203} \times 1.233 \times 0.742$(if female) [23]. In the study, all the patients received 30-month follow-up after pPCI until MACEs. The MACEs were defined as the composite of cardiac death, clinically driven target lesion revascularisation, recurrent target vessel myocardial infarction, cardiogenic shock or demonstrated congestive heart failure.

### 2.4. Statistical analysis

Continuous variables were presented as mean ± standard deviation(SD) or median (range) according to the presence or absence of normal distribution, and categorical data are reported as absolute numbers and percentages. To compare with the baseline characteristics, the TG/HDL-C ratio was divided into two groups by the median (0.8588) of the cohort: high (>0.8588) and low (≦0.8588) levels. Differences in continuous variables classified by the median of TG/HDL-C ratio were assessed by Mann–Whitney *U* test or Student *t*-test as appropriate. Differences in categorical variables were evaluated by Chi-square test. Furthermore, to explore the prognostic value of the variables, a best cut-off point with significant prognostic value suggested by the cut-off finder was used in the univariate Cox regression analysis. In case of no available significant discriminated value, the best cut-off point was set as the median or mean of continuous variables. Multivariate Cox regression proportional hazard model was further performed to evaluate the association of TG/HDL-C ratio with the MACEs in patients with STEMI following pPCI by adjusting the parameters found to be significant in the univariate analysis. Considering the possible effect of gender variation on the clinical utility of TG/HDL-C ratio, a univariate analysis and gender- stratified multivariate Cox regression proportional hazard models with different adjustments were applied. Model "a" was adjusted for age; model "b" with additional adjustment by the parameters found to be significant in the univariate analysis. The statistical analyses were performed using the SPSS 17.0 software package, and a $p < 0.05$ was considered statistically significant.

## 3. Results

### 3.1. Patient characteristics and analysis of TG/HDL-C ratio

A total of 464 consecutive STEMI patients following pPCI were included in the study and the baseline characteristics of the study population were summarized in Table 1. The median of TG/HDL-C ratio at admission in the study was 0.8588 with a range from 0.01 to 6.41. Participants were categorized into 2 groups according to their TG/HDL-C ratio. Two hundred and thirty-two patients with a TG/HDL-C ratio > 0.8588 were defined as the high TG/HDL-C group, while the remained with a TG/HDL-C ratio ≦0.8588 were defined as the low TG/HDL-C group. The relationships between TG/HDL-C ratio and clinical parameters are presented in Table 1. The TG/HDL-C ratio was found to be significantly associated with age($p = 0.017$), history of diabetes ($p = 0.017$), heart rate($p = 0.011$), TG($p < 0.001$), HDL-C($p < 0.001$) and Gensini score($p = 0.034$).

### 3.2. Associations between TG/HDL-C ratio, lipid profiles, clinical characteristics and clinical outcome in the overall population

During the 30-month follow-up period, 118 (25.4%) patients experienced MACEs. As shown in Table 2, The age ($p < 0.001$),systolic blood pressure($p = 0.001$),heart rate ($p < 0.001$), presence of pathological Q wave($p = 0.004$),anterior wall myocardial infarction ($p = 0.005$), Killip's grade ($p = 0.001$), left ventricular and diastolic diameter ($p < 0.001$), left atrial diameter ($p = 0.001$),white blood cells ($p = 0.002$),neutrophils proportion ($p < 0.001$),hemoglobin ($p < 0.001$),platelet($p = 0.001$), creatinine($p < 0.001$),uric.

Acid ($p < 0.001$),total cholesterol ($p < 0.001$),triglyeride ($p = 0.044$), high-density lipoprotein cholesterol ($p = 0.001$),low-density lipoprotein ($p = 0.021$), peak cTnI 9p = 0.001),peak CK- MB ($p = 0.014$) and Gensini score ($p = 0.002$) were found be significantly associated with MACEs in the univariate Cox regression analysis. However, no significant association was revealed for TG/HDL-C ratio (p = ns). To identify the independent prognostic factors, significant factors revealed by the univariate analysis were included in the multivariate analysis. The results of the multivariate analyses qualified that an alder age ($p = 0.015$,HR = 2.045), presence of pathological Q wave ($p = 0.016$,HR = 1.622), presence of anterior wall myocardial infarction ($p = 0.017$,HR = 1.774), larger left atrial diameter ($p = 0.015$,HR = 1.677),elevated white blood cells ($p = 0.001$,HR = 2.200), elevated platelet($p = 0.033$,HR = 2.301),increased creatinine concentration ($p = 0.001$,HR = 1.938), increased total cholesterol concentration ($p = 0.002$,HR = 1.981), increased triglyeride concentration ($p = 0.027$,HR = 5.363) and high peak cTnI ($p = 0.001$,HR = 3.452) might independently predict MACEs in 30 months in patients with STEMI following pPCI.