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Evaluation of triglyceride-glucose index, triglyceride to high-density lipoprotein cholesterol ratio, and other lipid ratios in hypertension

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ABSTRACT

Background: Hypertension is one of the most common diseases with increasing morbidity and mortality. HTN is associated with cardiovascular risk factors such as insulin resistance (IR) and hyperlipidemia. Recently, triglyceride-glucose (TyG) index has been proposed as a marker for insulin resistance. **Aims and Objectives:** This study aimed to assess TyG index, triglyceride to high-density lipoprotein ratio, and other lipid ratios in HTN patients. **Materials and Methods:** The present study was conducted on 200 subjects and was categorized into two groups. 100 hypertensive patients were considered as cases and 100 healthy individuals as controls. Serum sample of the subjects was used for the estimation of total cholesterol, triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C). Low-density lipoprotein (LDL) cholesterol was calculated. TyG index and TG/HDL ratio and other lipid ratios were calculated. Blood pressure (BP) was recorded. **Results:** In this, BP, total cholesterol, TG, LDL, Very low-density lipoprotein cholesterol, Non-HDLC, TC/HDL ratio, TG/HDL ratio, and TyG index were increased in cases and HDL and HDL/LDL ratio were decreased. Study parameters were positively correlated with TyG index and TG/HDL ratio, except HDL, and HDL/LDL ratio. **Conclusion:** The study concludes that significantly increased TyG index and TG/HDL ratio in hypertensive cases and their correlation with blood pressure.

Key words: Hypertension; Triglyceride-glucose index; Triglycerides/high-density lipoprotein ratio

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INTRODUCTION

Hypertension is one of the most common diseases with increasing morbidity and mortality. Hypertension is the 3rd leading cause of death and disability.[1] It is an independent risk factor for coronary heart disease (CHD).[2] Globally, more than 34% of males and 28% of women aged ≥25 years being affected by high blood pressure (BP). In India, the prevalence of HTN among individuals aged above 18 and 65 years was approximately 30 and 52%, respectively.[3] The prevalence in urban area is around 25% and in rural areas 10%. It accounts for 57% of all stroke deaths and 24% of all CHD deaths in India.[4]

HTN usually clustered with cardiovascular risk factors such as obesity, insulin resistance (IR), and hyperlipidemia.[5] A few studies reported the association between IR and HTN.[6,7] The coexistence of IR and HTN can result in increased risk of cardiovascular diseases (CVD) and type 2 diabetes mellitus (T2DM).[8] It is well established that both glucose and lipid abnormalities are linked with HTN. In hypertensive patients, dyslipidemia has been reported to be

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50–80%.[9] Similarly, T2DM and HTN are common causes of morbidity and risk factors for CVD. IR, sympathetic nervous system activation, and renin-angiotensin-aldosterone system are thought to be linking pathophysiological mechanisms of T2DM, dyslipidemia, and HTN.[10]

Recently, triglyceride-glucose (TyG) index is gaining importance as an substitution for IR.[11,12] It is calculated as: In (fasting triglycerides [TG] [mg/dl] × fasting glucose [mg/dl])/2.[13] Studies have reported the association between TyG index and HTN,[14] arterial stiffness, and calcification of coronary arteries.[15] TyG index can also predict the severity and outcomes of coronary artery diseases.[16] Association of TyG index with T2DM has also been reported.[17]

However, a very few studies were conducted to assess the association between the TyG index and HTN. Therefore, this study aimed to assess TyG index, triglyceride to high-density lipoprotein ratio, and other lipid ratios in HTN.

Aims and objectives

This study aimed to assess TyG index, triglyceride to high-density lipoprotein ratio, and other lipid ratios in HTN patients.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Biochemistry in association with Department of General Medicine, Veer Surendra Sai Institute of Medical Sciences and Research, Sambalpur, Odisha, India. The study was pre-approved by the Institutional Ethics Committee for the final permission. Two hundred subjects were involved in this study and informed consent was obtained from all the study subjects. Study subjects were divided into two groups. One hundred hypertensive patients were considered as cases and 100 healthy individuals were considered as controls. Study subjects age ranged between 25 and 55 years.

Inclusion criteria for cases and controls

Newly diagnosed hypertensives with BP ≥140/90 mmHg were included as cases and those with normal BP were included as controls.

Exclusion criteria

Patients with renal diseases, diabetes mellitus, congestive cardiac failure, cerebrovascular disease, patients with urinary tract infection, pregnant women, patients with obstructive uropathy, and nephrolithiasis were excluded from the study.

Sample collection and analysis

Under aseptic conditions, 5 ml of fasting blood samples were collected, centrifuged and obtained sample was used for the estimation of total cholesterol, TG, and high-density lipoprotein cholesterol (HDL-C). Low-density lipoprotein cholesterol (LDL-C) was calculated by the Friedewald formula. The TyG index was calculated by the following formula: In (fasting TG [mg/dl] × fasting glucose [mg/dl])/2.[13] Atherogenic index of plasma, calculated using the formula: ([log TG/HDL-C])[18] and other lipid ratios were calculated. BP was recorded.

Statistical analysis

The results were represented in Mean±SD. Pearson correlation coefficient was applied. The $P<0.05$ considered as statistically significant. Data were analyzed using SPSS version 20.0.

RESULTS

In the present study, 100 hypertensive patients as cases and 100 age- and gender-matched healthy subjects as controls were involved. In healthy controls, 56 (56%) were male and 44 (44%) were female. In the hypertensive cases, 55 (55%) were male and 45 (45%) were female. Mean age 45.5±9.0 years, systolic BP (SBP) 160.2±31.4 mmHg, diastolic BP (DBP) 103.5±12.0 mmHg, serum total cholesterol 170.6±36.4 mg/dl, serum TG 154.8±47.2 mg/dl, LDLC 104.1±31.3 mg/dl, very low-density lipoprotein cholesterol (VLDL)-C 30.9±9.4 mg/dl, non-HDLC 135.1±33.0 mg/dl, TC/HDL ratio 4.97±1.11, TG/HDL ratio 0.63±0.17, and TyG index 4.77±0.16 were significantly elevated in hypertensive patients than healthy controls. Serum HDLC 35.4±8.7 mg/dl and HDL/LDL ratio 0.36±0.11 were decreased significantly in hypertensive cases than controls (Table 1).

In the present study, SBP (r=0.533), DBP (r=0.521), total cholesterol (r=0.423), triglyceride (r=0.949), LDLC

Table 1: Comparison of study parameters between cases and healthy controls

Parameters	Controls Mean±SD (n=100)	Cases Mean±SD (n=100)	P-value
Age (years)	39.8±6.8	45.5±9.0	<0.001*
SBP (mmHg)	122.9±7.3	160.2±31.4	<0.001*
DBP (mmHg)	81.0±4.1	103.5±12.0	<0.001*
Total cholesterol (mg/dl)	141.2±18.9	170.6±36.4	<0.001*
Triglyceride (mg/dl)	111.2±18.6	154.8±47.2	<0.001*
HDLC (mg/dl)	41.8±5.9	35.4±8.7	<0.001*
LDLC (mg/dl)	77.1±16.2	104.1±31.3	<0.001*
VLDLC (mg/dl)	22.2±3.7	30.9±9.4	<0.001*
Non-HDLC (mg/dl)	99.3±16.2	135.1±33.0	<0.001*
TC/HDL ratio	3.39±0.40	4.97±1.11	<0.001*
HDL/LDL ratio	1.93±0.42	0.36±0.11	<0.001*
TG/HDL ratio	0.42±0.02	0.63±0.17	<0.001*
TyG index	4.59±0.09	4.77±0.16	<0.001*

*P≤0.05 considered significant. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HDLC: High-density lipoprotein cholesterol, LDLC: Low-density lipoprotein cholesterol, VLDL: Very low-density lipoprotein cholesterol

(r=0.303), VLDL (r=0.949), non-HDLC (r=0.533), TC/HDLC ratio (r=0.583), and TG/HDLC ratio (r=0.839) were positively correlated with TyG index. HDLC (r=−0.698) and HDL/LDL ratio (r= −0.679) were negatively correlated with TyG index (Table 2).

In the present study, age (r=0.152), SBP (r=0.511), DBP (r=0.507), total cholesterol (r=0.192), triglyceride (r=0.874), LDLC (r=0.177), VLDL (r=0.874), non-HDLC (r= 0.403), TC/HDLC ratio (r=0.714), TG/HDLC ratio (r=0.392), and TyG index (r=0.839) were positively correlated with TG/HDL ratio. HDLC (r= −0.698) and HDL/LDL ratio (r= −0.772) were negatively correlated with TG/HDL ratio (Table 3).

DISCUSSION

In this study, TyG index and TG/HDL ratio were significantly increased and were positively correlated with BP. Dyslipidemia and increased atherogenic ratios were observed in this study and dyslipidemia – a conventional risk factor for CVD.

Table 2: Correlation of TyG index with the study parameters

Parameters	r-value	P-value
Age	0.109	0.123
SBP	0.533**	0.000
DBP	0.521**	0.000
Total cholesterol	0.423**	0.000
Triglyceride	0.949**	0.000
HDLC	−0.698**	0.000
LDLC	0.303**	0.000
VLDLC	0.949**	0.000
Non-HDLC	0.533**	0.000
TC/HDLC ratio	0.583**	0.000
HDL/LDL ratio	−0. 679**	0.000
TG/HDL ratio	0. 839**	0.000

**Correlation is significant at the 0.01 level (2-tailed)

Table 3: Correlation of TG/HDLC with the study parameters

Parameters	r-value	P-value
Age	0.152*	0.032
SBP	0.326**	0.000
DBP	0.507**	0.000
Total cholesterol	0.192**	0.000
Triglyceride	0.874**	0.000
HDLC	−0.698**	0.000
LDLC	0.177**	0.012
VLDLC	0.874**	0.000
Non-HDLC	0.403**	0.000
TC/HDLC ratio	0.714**	0.000
HDL/LDL ratio	−0.772**	0.000
TG/HDL ratio	0.392**	0.000
Ty glucose index	0. 839**	0.000

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (two-tailed)

However, exact pathophysiological mechanism responsible for the elevation of TyG and HTN is not clear. However, a few studies have suggested the mechanisms by which IR might affect elevating BP. In metabolic syndrome, IR is one of the components and also risk factor for increased BP. It was reported that more visceral fat indicates the metabolic alterations causing increased IR, cardiometabolic risk and HTN. Therefore, IR is important factor for indicating the development of HTN.[19,20]

It was reported that TyG index was correlated with IR and proposed as surrogate index of IR.[21,22] A few studies reported the importance of TyG index in assessment of cardiovascular risk.[23-25] IR-compensatory hyperinsulinemia can cause increased activation of the carotid body, leading to increased activity of sympathetic nervous system, prompting the secretion of adrenaline and norepinephrine, which resulting in increased cardiac output and peripheral vascular resistance. Vascular smooth muscle may be thickened due to increased levels of catecholamine, inducing HTN.[26] Even BP may also be increased by IR through RAS activation and increased endothelin synthesis. Increased endothelin may contract blood vessels, contributing to HTN development.[27,28]

In support of this study findings, Zhu et al.,[29] reported the correlation between TyG index and HTN. A study by Zhang et al.,[30] reported increased TyG index and TG/HDL-c levels were correlated with pre-HTN and HTN in normoglycemic subjects. A study by Liao et al.,[31] showed significantly elevated TyG index in heart failure with preserved ejection fraction (HFpEF) patients than in non-HFpEF patients and related to cardiac diastolic function, which indicates the occurrence of HFpEF in hypertensives.

Studies have reported the significance of other lipid ratios or atherogenic indexes and were strong indicators of the CVD risk and T2DM.[32] In this, TG/HDL ratio is also increased in cases than controls. Increased non-HDL-C also used to assess atherogenic risk.[18,33]

Limitations of the study

The sample size was small. Estimation of insulin was not done.

CONCLUSION

The study concludes that significantly increased TyG index, TG/HDL ratio, TC/HDL ratio and decreased HDL/LDL ratio in hypertensive cases. TyG index and TG/HDL ratio was significantly correlated with BP and other lipid ratios. Increased TyG index may indicate IR in hypertensive patients. This may be useful for screening and

managing of HTN. Further studies with large sample size are recommended.

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Authors' Contributions:
JK- Concept and study design, prepared first draft of manuscript; **MA-** Interpreted the results; revision of the manuscript; **SB-** Reviewed the literature and manuscript preparation; **SB-** Concept, coordination, statistical analysis and interpretation; **NBT-** Preparation of manuscript.

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