Association Of Triglyceride Glucose Index With Atherogenic Indices In Essential Hypertension

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Abstract

Background and aim: Insulin resistance has been linked to both triglyceride-glucose index (TyG) and hypertension, and it is a major risk factor for cardiovascular disease. The present study aimed to determine the TyG index and atherogenic indices in essential hypertensive subjects and find out the association between them.

Materials and Methods: In this case-control study, 250 patients with essential hypertension and 250 healthy controls were recruited and their serum lipids were analyzed using a Biosystem BA-400 chemistry analyzer. TyG index and atherogenic indices were calculated.

Results: Triglyceride-glucose index was increased significantly in essential hypertension subjects compared to controls. All the atherogenic indices i.e. atherogenic index of plasma (AIP), cardiac risk ratio (CRR), and atherogenic coefficient (AC) were significantly increased in essential hypertensive subjects compared to controls. Additionally, the TyG index demonstrated a statistically significant positive association with the atherogenic index of plasma, cardiac risk ratio, and atherogenic coefficient in participants with essential hypertension.

Conclusion: In conclusion, the TyG index was found to be positively associated with atherogenic indices in essential hypertension, suggesting essential hypertensive subjects are at increased risk for cardiovascular disease.

Keywords: Triglyceride-glucose index; Atherogenic indices; Essential hypertension

INTRODUCTION:

The prevalence of hypertension has grown steadily over the past ten years, and it now represents a significant global disease burden. In 1975, there were 590 million cases of hypertension globally (the prevalence was 14.5%). This number rose to 1.13 billion in 2015 (15.3% prevalence). The number of people with hypertension is expected to reach 1.56 billion by 2025.1 High cardiovascular disease mortality and morbidity are significantly correlated with hypertension, which has a significant negative impact on public health. Furthermore, the morbidity of hypertension has increased significantly, making the onset of hypertension a growing health concern. This is due to the aggravation tendency of population aging and unfavorable behavior of impairing health spreading among people.2

The most significant modifiable risk factor for cardiovascular disease is most likely hypertension. A significant risk factor for cardiovascular disease (CVD) is insulin resistance (IR).3 According to reports, the triglyceride-glucose (TyG) index closely resembles the hyperinsulinemic-euglycemic clamp and has been proposed as a simple and reliable alternative to IR.4,5 Previous studies have demonstrated a strong correlation between the TyG index and vascular damage.6 Several studies have also discovered a connection between hypertension and IR.7,8 Furthermore, a recent cross-sectional study found that the TyG index and hypertension are closely related.9

The atherogenic index of plasma (AIP) is a vital parameter that can be used independently to determine cardiac risk. A person's chance of getting atherosclerotic issues rises with any alterations to their lipid profile. The risk of cardiovascular disease is strongly correlated with the atherogenic index of plasma (AIP), which is defined as the logarithm [log] of the ratio of plasma triglyceride (TG) to high-density lipoprotein cholesterol (HDL-C). In comparison to conventional lipid measures, the atherogenic index of plasma is a better predictor of the fractionated esterification rate of HDL-C. It can be used as a diagnostic marker when the other atherogenic risk markers appear normal. The AIP calculation is used to estimate the "zone of atherogenic risk" values.10 The atherogenic coefficient (AC), which measures the proportion of non-HDL-C to HDL-C, is another ratio that depends on HDL-C levels in assessing the risk of coronary artery disease. The
Castelli risk index 1 (TC/HDL-C) is a risk factor for coronary artery disease that is independent of other risk factors and has a high degree of prognostic significance.\textsuperscript{11}

Understanding the precise relationship between the TyG index and atherogenic indices in hypertensive people is crucial since this high-risk population is more likely to develop CVD. Therefore, our study aimed to determine the TyG index and atherogenic indices in essential hypertensive subjects and find out the association between them.

**MATERIALS AND METHODS:**

**Study design and population:**

After getting approval from the Institutional Ethical Committee to proceed with the research, this case-control study was carried out over the course of a year in the Department of Biochemistry at the Shyam Shah Medical College in Rewa, Madhya Pradesh, India. For the current study, a total of 500 subjects of either sex were chosen. 250 of them were healthy control volunteers, and 250 of them were patients with essential hypertension. 250 patients with essential hypertension (of either sex) between the ages of 35 and 75 were chosen from the OPD of the medicine ward of Shyam Shah Medical College and associated Hospital in Rewa, Madhya Pradesh, India. To decide which cases of essential hypertension should be included, the JNC 7 (Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure) criteria were employed.\textsuperscript{12} 250 healthy individuals of the same age group who did not exhibit any symptoms or warning signs of hypertension and who had no family history of the condition were chosen from in and around the hospital as controls. After explaining the study in detail, each participant gave their written consent.

**Exclusion criteria:**

Patients having the following illness or condition were not allowed to participate in the study: secondary hypertension, severe hepatic failure, renal failure, unstable cardiovascular condition, past incidences of cerebrovascular conditions, collagenous tissue disease, malignancy, thyroid disease, severe depression, dementia, and diabetes mellitus. The current study did not include any pregnant women.

**Anthropometric measurements:**

The subjects were barefoot and wearing minimal clothing, and measurements of height and weight were taken with normal equipment. Weight was measured using calibrated electronic weighing scales, while height was determined to the nearest centimeter using a portable stadiometer. Body mass index (BMI) was calculated as weight in kilograms, divided by height in meters squared (kg/m\textsuperscript{2}). All of the measurements were taken by the same person.

**Blood pressure measurements:**

The systolic and diastolic blood pressures were assessed after 10 minutes of rest using a mercury sphygmomanometer in accordance with standard medical procedure.

**Biochemical measurements:**

Approximately 05 ml of fasting venous blood was collected from cases and controls under aseptic conditions, and depending on the analysis to be performed; the sample was distributed into two tubes. About 2 ml of blood was taken into a fluoride bulb to determine the concentration of plasma glucose and the remaining 03 ml blood sample was dispersed into the plain tube for lipid profile analysis. Following blood collection, the samples were centrifuged at 3000 rpm for 10 minutes to get serum/plasma. The fasting blood glucose and lipid parameters were analyzed by standard methods using a Biosystem BA-400 chemistry analyzer. Friedewald’s equation was used to calculate low-density lipoprotein and very low-density lipoprotein cholesterol.\textsuperscript{13} The cardiac risk ratio (CRR) was computed as TC/HDL, the atherogenic coefficient (AC) as non-HDL/HDL, and the atherogenic index of plasma (AIP) as logTG/HDL, where TG and HDL concentrations are in mmol/L.\textsuperscript{14,15}

**STATISTICAL ANALYSIS:**

Statistical Package for Social Science version 20 (IBM, SPSS Statistics 20, Armonk, NY, USA) was used to analyze the data, and findings of the analysis were reported as mean±SD values. The graph was created with GraphPad Prism 5. The “student-independent sample t-test” was used to look at statistical differences between cases and controls. The chi-squared test ($\chi^2$ test) was used for the categorical data. Pearson's correlation coefficient was determined to find out the correlation between the TyG index and atherogenic indices. A $p$-value of less than 0.05 was considered significant.

**RESULTS:**

The baseline characteristics of the studied subjects are shown in Table 1. Age and gender differences between patients with essential hypertension and those acting as controls were statistically insignificant. In comparison to controls, essential hypertension cases had statistically significant higher BMI, SBP, and DBP. The mean fasting blood glucose level and lipid profile of the studied subjects are shown in Figure 1. Fasting blood glucose (FBG) and all lipid parameters, including TC, TG, LDL, and VLDL, except HDL, were statistically significantly higher in essential hypertension subjects compared to control subjects, while HDL was statistically significantly lower. Table 2 shows the comparison of the TyG index and atherogenic indices between the studied groups. TyG index was increased significantly in essential hypertension subjects compared to controls. All the atherogenic indices i.e. AIP, CRR, and AC were increased in cases compared to controls.
and were statistically significant. Table 3 shows the correlation of the TyG index with atherogenic indices in essential hypertension subjects. In subjects with essential hypertension, the TyG index showed a statistically significant positive correlation with the atherogenic index of plasma, cardiac risk ratio, and atherogenic coefficient.

Table 1: Baseline characteristics of studied subjects.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Controls</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>48.24±11.23</td>
<td>48.70±11.82</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>113/137</td>
<td>114/136</td>
</tr>
<tr>
<td>BMI (Kg/m²)</td>
<td>21.89±1.00</td>
<td>27.60±1.68</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>115.32±3.95</td>
<td>155.35±7.40</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>76.12±4.95</td>
<td>96.03±5.57</td>
</tr>
</tbody>
</table>

NS Not significant (p>0.05); *Significant at p<0.01; BMI=Body mass index; SBP=Systolic blood pressure; DBP=Diastolic blood pressure

Table 2: TyG index and atherogenic indices in studied subjects.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Controls</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>TyG Index</td>
<td>4.67±0.05</td>
<td>5.00±0.11</td>
</tr>
<tr>
<td>AIP</td>
<td>0.05±0.05</td>
<td>0.44±0.11</td>
</tr>
<tr>
<td>CRR</td>
<td>3.26±0.38</td>
<td>5.98±0.79</td>
</tr>
<tr>
<td>AC</td>
<td>2.26±0.38</td>
<td>4.98±0.79</td>
</tr>
</tbody>
</table>

*Significant at p<0.001; TyG index=Triglyceride glucose index; AIP=Atherogenic index of plasma; CRR=Cardiac risk ratio; AC=Atherogenic coefficient

Table 3: Correlation of TyG index with atherogenic indices in essential hypertension subjects.

<table>
<thead>
<tr>
<th>Variables</th>
<th>With TyG Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r-value</td>
</tr>
<tr>
<td>AIP</td>
<td>0.886</td>
</tr>
<tr>
<td>CRR</td>
<td>0.506</td>
</tr>
<tr>
<td>AC</td>
<td>0.506</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level (2-tailed); TyG index=Triglyceride glucose index; AIP=Atherogenic index of plasma; CRR=Cardiac risk ratio; AC=Atherogenic coefficient

DISCUSSION:
Patients with essential hypertension participated in this case-control study, which was conducted in a hospital setting. The goal of the current study was to examine the TyG index and atherogenic indices among patients with essential hypertension in a central Indian setting. In addition, this study also determined the possible association between the TyG index and atherogenic indices in essential hypertension.

Essential hypertension is typically found in conjunction with other risk factors for cardiovascular disease, including advanced age, obesity, insulin resistance, diabetes, and dyslipidemia.16,17 Insulin resistance has been linked to hypertension by a significant amount of evidence gleaned from clinical studies as well as epidemiological research.18,19 A considerable increase in the risk of cardiovascular disease and type 2 diabetes mellitus might result from the coexistence of insulin resistance and hypertension.19 Hyperinsulinemic-euglycemic clamp analysis is the gold standard for determining insulin resistance.20 However, it is difficult to carry out in real-world circumstances because it requires a lot of time and effort as well as a lot of physical labor. It has been suggested that HOMA-IR is a more straightforward approach, and its outcomes correlate favorably with those determined by clamp analysis.21 Because serum insulin is not typically measured in clinical settings, it also has limited usefulness. The TyG index has recently been suggested for
Recent research has revealed that atherogenic indices are better indices because they can more correctly reflect the composition of plasma lipoproteins while also taking into account the interactions that occur between the various lipid fractions. The mathematical modeling of important cardiovascular factors is also made easier by the fact that AIP has a normal distribution in comparison to more conventional single lipid variables. The current study found that people with essential hypertension had significantly higher levels of atherogenic indices, such as AIP, CRR, and AC, compared to controls. Yildirim et al. also found significantly increased AIP in hypertensive subjects compared to normotensive subjects. Yin et al. 2021 analyzed 4744 Chinese individuals with essential hypertension to explore the association between AIP and arterial stiffness and found a positive association between AIP and arterial stiffness in essential hypertension patients. Moreover, AIP reflects the distribution of small dense low-density lipoprotein (sdLDL) and sdLDL levels are strongly associated with oxidative stress and inflammation, which puts patients with essential hypertension at increased risk for cardiovascular disease. In addition, a positive significant association was found between the TyG index and atherogenic indices in patients with essential hypertension, suggesting hypertensive individuals are prone to the development of cardiovascular disease. The following limitations inevitably exist in our research.

1. The study was conducted at a single hospital and had a smaller number of individuals; therefore its findings cannot be applied to the entire population.
2. We were unable to examine the correlation between the TyG index and atherogenic indices and other known risk factors for cardiovascular disease.
3. It was not possible to establish a cause-and-effect relationship between the TyG index and atherogenic indices and hypertension.

CONCLUSION:
In conclusion, it was discovered that a positive association exists between the TyG index and atherogenic indices in essential hypertension. The TyG index has the potential to be a helpful marker for predicting cardiovascular disease in hypertensive patients due to the ease with which it can be measured and its high level of usefulness. On the other hand, additional research is required to corroborate the findings.

REFERENCES: