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Association of glycosylated hemoglobin level with lipid ratio and individual lipids in type 2 diabetic patients

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ABSTRACT

Objective: To study the correlation of lipid ratios and individual lipid indexes of patients with type 2 diabetes with glycosylated hemoglobin (HbA_{1c}). **Methods:** Samples were collected from 128 type 2 diabetic patients (aged 19-90 years; male 72, female 56). The sera were analyzed for HbA_{1c}, total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C). According to the HbA_{1c} level, the patients were divided into three groups, group A (HbA_{1c} <7%, n=31), group B (7%≤HbA_{1c}≤10%, n=48), and group C (HbA_{1c} >10%, n=49). The correlation of HbA_{1c} with lipid ratios & individual lipid indexes were analyzed. **Results:** With the increased level of HbA_{1c}, LDL-C had a significantly increasing trend (P<0.05); whereas TC went up with the increased HbA_{1c}, without any significant differences between three groups. There was no significant correlation between HbA_{1c} and TG or HDL-C. With the increased level of HbA_{1c}, TC/HDL-C, LDL-C/HDL-C ratios were gradually increased, with significant differences among groups (P<0.05). The lipid ratios, especially LDL-C/HDL-C ratio was more susceptible to impaired lipid metabolism in T2DM patients than individual lipid. **Conclusions:** LDL-C/HDL-C ratio is helpful in assessing and reducing the risk of cardiovascular disease caused by impaired lipid metabolism in type 2 diabetic patients.

1. Introduction

Diabetes is a global disease with rapid increase in both developed and developing countries[1], especially in China. Hyperglycemia is one remarkable feature of diabetes patients. As an important indicator of long-term blood glucose control, glycosylated hemoglobin(HbA_{1c}) can reflect cumulative blood glucose for 2-3 months[2]. Diabetes Complications and Control Trial has established HbA_{1c} as the gold standard for glycemic control, and proposes HbA_{1c} at ≤7% as critical value for reducing the risk of vascular complications[3]. Elevated HbA_{1c} has been regarded as an independent risk factor for coronary heart disease(CHD) in patients with or without diabetes[4]. Ravipati *et al*[5] also observed a direct correlation between HbA_{1c} concentration and the severity of coronary artery disease (CAD) in diabetic patients.

It is reported that most patients with type 2 diabetes could have dyslipidemia at varying degrees, characterized by increased levels of TG and LDL-C and decreased HDL-C. Giansanti *et al*[6] also observed significantly higher levels of hypercholesterolemia and hyperlipidemia in type 2 diabetic patients with cardiovascular disease(CVD) compared to diabetic patients without CVD, which may elevate the mortality rate of these patients[7]. At recent years, more data support that the lipid ratio is more sensitive in reflecting the morbidity and severity of CHD than individual lipid[8,9]. However, little is known about the relationship between hyperglycemia and lipid ratio levels in type 2 diabetes mellitus (T2DM) patients.

In this study, we examined the correlation between the severity of glucose intolerance, which was reflected by HbA_{1c} level, and blood lipid ratio & individual lipid, to evaluate which is the most sensitive in predicting risk and severity of CVD in T2DM patients.

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2. Materials and methods

2.1. Objects

A total of 128 patients with T2DM admitted during January 2010 to July 2010 to our hospital were selected, aged 19–90 years old [(60.05±14.58) yrs], including male 72 and female 56. All patients underwent oral glucose tolerance test + insulin release test and were diagnosed as T2DM. All of them had no lipid-controlled drug in recent three months.

2.2. Methods and groups

Venous blood samples were collected after at least 8 h fasting. The sera were analyzed for HbA_{1c}, total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C). HbA_{1c} was measured by micro-column chromatography, TC and TG by enzymatic method, HDL-C and LDL-C by the direct method. TG/HDL-C, TC/HDL-C, LDL-C/HDL-C ratios were calculated, respectively. All patients were categorized into 3 groups according to their HbA_{1c} level: group A (HbA_{1c} <7%, n=31), group B (7%≤HbA_{1c}≤10%, n=48), and group C (HbA_{1c} >10%, n=49). The correlation of lipid ratios and individual lipid indexes among three groups were analyzed.

2.3. Statistic analysis

The data was analyzed by SPSS16.0 statistical software. Data are expressed as the mean±SD. The relation of HbA_{1c} and various blood lipid parameters was evaluated by one-way analysis of variance (ANOVA). P <0.05 was considered as statistically significant.

3. Results

3.1. Correlations between blood individual lipid indexes and HbA_{1c}

TC was gradually increased as increasing HbA_{1c}; however, there was no significant correlation between TC and HbA_{1c} (Table 1) (F=2.738, P=0.069). LDL-C was increased as increasing HbA_{1c}, and there was a significant correlation between HbA_{1c} and LDL-C (F=4.300, P=0.016). HbA_{1c} did not show any significant correlation with TG (F=1.133, P=0.325), or HDL-C (F=1.827, P=0.165).

3.2. Correlations between blood lipid ratio and HbA_{1c}

HbA_{1c} and TG/HDL-C ratio did not show any significant correlation with HbA_{1c} (Table 2) (F=1.213, P=0.301). With the increased level of HbA_{1c}, TC/HDL-C and LDL-C/HDL-C ratio showed a definite increasing trend, and there was a significant correlation between HbA_{1c} and TC/HDL-C ratio (F=3.326, P=0.039). LDL-C/HDL-C ratio was also gradually increased which had significant correlation with HbA_{1c} (F=6.284, P=0.003). The lipid ratios, especially LDL-C/HDL-C ratio was more susceptible to impaired lipid metabolism in T2DM patients than individual lipid.

4. Discussion

We observed significant correlation between HbA_{1c} and LDL-C in diabetic patients, which is in agreement with the findings of several other investigators who also reported significant correlations between HbA_{1c} and individual blood lipid[10,11]. However, we did not observe significant correlation of HbA_{1c} with TG, TC or HDL-C. Diabetic patients with poor glycaemic control exhibited a significant increase in TC/HDL-C and LDL-C/HDL-C ratios, especially in LDL-C/HDL-C ratios. The result of this study clearly showed that the control of impaired glycaemic which is defined by HbA_{1c} was proportionally related with degree of dyslipidemia, including LDL-C, TC/HDL-C and LDL-C/HDL-C ratios, especially LDL-C/HDL-C ratio. The reason maybe because that the change of ratios is earlier than individual lipid, especially in patients with normal blood lipid.

CVD is the main cause for mortality and disability in individuals older than 65 years, despite the progressive decline in the incidence of CVD since 1970s[12]. Therefore, prevention of CVD is essential[13]. It is reported that T2MD patients had increased susceptibility to vascular disease

Table 1
Correlations between blood individual lipid indexes and HbA_{1c}.

Group	TG(mmol/L)	TC(mmol/L)	HDL-C(mmol/L)	LDL-C(mmol/L)
A	1.64±1.26	4.25±1.20	1.32±0.52	2.23±0.99
B	1.62±0.80	4.43±1.47	1.15±0.31	2.77±1.15
C	2.01±1.87	4.91±1.31	1.24±0.39	2.98±1.16

Table 2
Correlations between blood lipid ratio and HbA_{1c}.

Group	TG/HDL-C	TC/HDL-C	LDL-C/HDL-C
A	1.57±1.49	3.47±1.22	1.81±0.89
B	1.50±0.83	4.03±1.06	2.47±0.83
C	2.02±2.42	4.23±1.52	2.54±1.09

associated with LDL-C[14]. To the contrary, Cardenas *et al*[15] found that HDL-C level was a major and independent risk factor, and had more relationship with the development of CAD than total cholesterol and LDL-C level. Elizabete *et al*[16] also reported that low HDL-C was a risk factor for CVD of the elder, whereas LDL-C showed no significant association with the development of CVD.

In recent, more data support that lipid ratio is more sensitive in reflecting the morbidity and severity of CHD than individual lipid[8,9]. Blood lipid ratio is more meaningful than individual blood lipid level in judging the severity of CAD[17]. Pan *et al*[18] showed lipid ratio is more meaningful in the early prevention and diagnosis of CHD than the individual serum lipids. LDL-C/HDL-C ratio is increased more obviously than other lipid indicators in T2DM patientscomplicated with CAD[19]. Shai *et al*[8] reported TC/HDL-C, LDL-C/HDL-C and apo B/apo A ratios are more susceptible to increased cardiovascular mortality than individual blood lipid, and they deemed that ratios have the effect of inducible-arteriosclerosis and anti-arteriosclerosis. In conclusion, most patients with type 2 diabetes have dyslipidemia to varying degrees. With the increased levels of HbA_{1c}, dyslipidemia become more severe. Compared with individual lipid indexes, the changes of lipid ratio can reflect impaired lipid metabolism at earlier stage, and the most sensitive indicator is LDL-C/HDL-C ratio. Thus, LDL-C/HDL-C ratio is helpful in assessing and reducing the risk of cardiovascular disease due to impaired lipid metabolism in type 2 diabetic patients.

Conflict of interest statement

We declare that we have no conflict of interest.

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