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Glycated albumin is not significantly correlated with body mass index in patients with acute-onset type 1 diabetes

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ABSTRACT

Background: No previous reports have clarified the relationship between glycated albumin (GA) and BMI in patients with acute-onset type 1 diabetes.
Methods: We conducted a cross-sectional study evaluating the correlation between GA and BMI in 209 patients with acute-onset type 1 diabetes and in 159 patients with type 2 diabetes who were designated as the control group. The correlation between fasting serum C-peptide immunoreactivity (CPR) and GA or BMI was also evaluated to clarify the impact of insulin secretion capacity on the relationship between GA and BMI.
Results: GA was significantly inversely correlated with BMI in patients with type 2 diabetes ($r = -0.317$, $p < 0.001$) but not in patients with type 1 diabetes ($r = 0.031$, $p =$ NS). In patients with type 2 diabetes, GA was significantly inversely correlated with fasting CPR, and BMI was significantly correlated with fasting CPR. In patients with type 1 diabetes, GA was significantly inversely correlated with fasting CPR ($r = -0.291$, $p < 0.001$), but BMI was not correlated with fasting CPR ($r = -0.010$, $p =$ NS).
Conclusions: Unlike in patients with type 2 diabetes, GA was not significantly correlated with BMI in patients with acute-onset type 1 diabetes.

1. Introduction

Glycated albumin (GA) is frequently used as an index of glycemic control for 2 or 3 weeks in clinical settings [1,2]. GA is also an index of postprandial plasma glucose or plasma glucose fluctuation, which cannot be sufficiently evaluated by glycated hemoglobin (HbA1c) [3,4]. Furthermore, in dialysis patients and pregnant women, GA is more useful than HbA1c as an index of glycemic control [5–8].

Several previous reports have shown that various factors influence GA [9]. Body mass index (BMI) is particularly known as an important factor that influences GA, and previous studies have reported that GA was relatively low in obese non-diabetic subjects [10,11] or in obese patients with type 2 diabetes [12,13]. However, no previous study has reported the association between BMI and GA in patients with type 1 diabetes.

Several recent studies have reported that intrinsic insulin secretion capacity was inversely associated with GA levels or the GA/HbA1c ratio in patients with type 1 [14,15] and type 2 diabetes [16,17]. Other reports have shown that intrinsic insulin secretion capacity influences the association between BMI and GA in patients with type 2 diabetes [18,19]. However, in patients with type 1 diabetes, no previous study has investigated the impact of intrinsic insulin secretion capacity on the association between BMI and GA.

2. Materials and methods

2.1. Participants, study design and setting

We conducted a cross-sectional study of 209 patients with acute-onset type 1 diabetes and in 159 patients with type 2 diabetes who were designated as the control group in Saitama Social Insurance Hospital and Kinki Central Hospital. We diagnosed acute-onset type 1 diabetes on the basis of the diagnostic criteria of the Japan Diabetes Society [20]. We only included participants with stable glycemic control (defined as HbA1c level changes within 0.5% during the previous 3 months) and no change of medication during the previous 3 months. We excluded participants with chronic liver disease, severe renal disease including ≥stage 3 diabetic nephropathy, thyroid disorder, anemia, malignancy and corticosteroid treatment because these disorders or conditions may lead to abnormal HbA1c and/or GA levels [16,17].

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This study was approved by the Ethical committee of Saitama social insurance hospital and Kinki central hospital, and written informed consent was obtained from all participants.

2.2. Measurements

Clinical characteristics, such as gender, age, height and duration of diabetes, were obtained from medical records. Body weight was measured at outpatient visits and used to calculate body mass index (BMI). Blood samples were collected at outpatient visits to measure plasma glucose, HbA1c, GA and C-peptide immunoreactivity (CPR) levels after overnight fasting. Plasma glucose levels were determined using glucose oxidase methods. HbA1c levels, expressed as National Glycohemoglobin Standardization Program (NGSP) values [21], were measured by high performance liquid chromatography. GA levels were measured by enzymatic methods using albumin-specific protease, ketoamine oxidase and albumin assay reagents (Lucica GA-L; Asahi Kasei Pharma) [22]. Fasting serum CPR levels were measured using a chemiluminescent enzyme immunoassay (Fujirebio, Inc), as described previously [16].

2.3. Statistical analysis

Data are presented as mean ± SD or as medians with interquartile range when distribution was skewed (duration of diabetes and fasting serum CPR) for continuous variables or numbers and percentages for categorical variables. We used the Mann–Whitney's *U*-test for continuous variables and the chi-square test for categorical variables to compare clinical characteristics of patients in the acute-onset type 1 diabetes group and the type 2 diabetes group. We analyzed correlations among BMI, GA or the GA/HbA1c ratio and serum CPR using the Pearson correlation coefficient. A $p < 0.05$ was considered statistically significant. All analyses were performed using Stata 11 data analysis and statistical software (StataCorp LP).

3. Results

3.1. Clinical characteristics of the patients

Clinical characteristics of the patients included in the study are shown in Table 1. The acute-onset type 1 diabetes group had significantly more females, had patients who were significantly younger and had patients with significantly lower BMI compared with the type 2 diabetes group. HbA1c was not significantly different between the 2 groups, but GA was significantly higher in the type 1 diabetes group than in the type 2 diabetes group. As a result, the GA/HbA1c ratio was also significantly higher in the type 1 diabetes group than in the type 2 diabetes group. In addition, fasting serum CPR level was significantly lower in the type 1 diabetes group than in the type 2 diabetes group.

3.2. Correlation among GA, BMI and fasting serum CPR

In the type 2 diabetes group, GA and the GA/HbA1c ratio were significantly inversely correlated with BMI (Fig. 1A and B). On the other hand, GA and the GA/HbA1c ratio were not significantly correlated with BMI in the type 1 diabetes group (Fig. 1C and D). GA was significantly inversely correlated with fasting serum CPR in both groups (Fig. 2A and B). The GA/HbA1c ratio was also significantly inversely correlated with fasting serum CPR in both groups. BMI was significantly positively correlated with fasting serum CPR (Fig. 3A) in the type 2 diabetes group but not in the type 1 diabetes group (Fig. 3B).

4. Discussion

Our findings revealed that GA and GA/HbA1c ratio were not significantly associated with BMI in patients with type 1 diabetes, unlike in patients with type 2 diabetes. Fasting serum CPR, a marker of intrinsic insulin secretion capacity, was significantly inversely associated with GA in patients with type 1 diabetes as well as type 2 diabetes. However, BMI was not significantly associated with fasting serum CPR in patients with type 1 diabetes, unlike in patients with type 2 diabetes. As a result, BMI is not significantly associated with GA only in patients with type 1 diabetes. We performed gender-specific analyses to investigate the impact of gender on the association among GA, BMI and fasting serum CPR, and the association was not changed by gender in both patients with type 1 and type 2 diabetes (data not shown).

Previous studies have reported that GA is significantly inversely associated with BMI in non-diabetic subjects [10,11] and patients with type 2 diabetes [12,13]. We have reported that the association of obesity and its related chronic inflammation with GA levels in non-diabetic subjects [11], and we assumed that chronic inflammation modified the association between GA levels and BMI in obese and non-diabetic subjects. However, no previous report showed the impact of chronic inflammation on the association between GA levels and BMI in patients with type 2 diabetes. On the other hand, previous reports have suggested that decreased BMI results in impairment of intrinsic insulin secretion, which leads to glucose fluctuation. As a result, GA was relatively high in patients with type 2 diabetes patients with low BMI compared with that in those with high BMI [16]. The present study also showed that BMI was positively correlated and GA was negatively correlated with fasting serum CPR in patients with type 2 diabetes, a finding that is consistent with previous studies [12,13,16].

In patients with acute-onset type 1 diabetes, GA was not significantly associated with BMI, unlike in non-diabetic subjects or patients with type 2 diabetes in the present study. Mean BMI in patients with acute-onset type 1 diabetes was low, but patients with Japanese acute-onset type 1 diabetes had generally lower BMI than those in

Table 1
Clinical characteristics of study patients.

	Type 2 diabetes	Type 1 diabetes	p-Value
Number	159	209	
Gender: female (%)	60 (37.7%)	126 (60.3%)	<0.001
Age (years)	63.4 ± 10.7	44.0 ± 15.5	<0.001
BMI (kg/m^2)	24.3 ± 3.8	20.1 ± 2.9	<0.001
Duration of diabetes (years)	10 (6–18)	13 (8–20)	0.007
HbA1c (%)	7.6 ± 0.9	7.5 ± 1.0	NS
GA (%)	20.4 ± 3.4	23.3 ± 4.5	<0.001
GA/HbA1c ratio	2.69 ± 0.33	3.08 ± 0.34	<0.001
Fasting serum CPR (ng/ml)	2.30 (1.60–3.00)	0.01 (0.01–0.12)	<0.001

Abbreviations: GA, glycated albumin; CPR, C-peptide immunoreactivity. Data are presented as mean ± SD, or median (interquartile range).