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Original Research Paper

Medicine

THE RELATIONSHIP BETWEEN DIFFERENT DIABETIC FACTORS IN IMPAIRED FASTING PLASMA GLUCOSE OBESE ELDERLY

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ABSTRACT

Background: In both developed and developing countries, the relationship between aging an obesity is similar and studies appear to be more important at all ages. Therefore, we focused on patients with impaired fasting blood glucose levels to see the baseline changes in insulin homeostasis. The current study seeks to explain the relationship between insulin secretion, insulin resistance, and glucose effects in obese elderly people.

Methods: We randomly enrolled 31subjects who were aged 65 years old. All these patients were obese (body mass index ≥ 25 kg/m^2) and the fasting plasma glucose (FPG) was between 100 and 125 mg/dl. Four diabetic factors were calculated and included first phase insulin secretion (PFIS), second phase insulin secretion (SFIS), insulin resistance (IR) and glucose effectiveness (GE).

Results: In the current study, we enrolled 18 male and 13 female subjects. The mean FPG was 108 (mg/dl) in both male and female. All the demographic data were non-significant when compared with male and female except the hemoglobin. When we compared these four diabetic factors with FPG, we found only SPIS was significantly negative correlated with FPG in both genders.

Discussion: FPG was correlated with SPIS only. FPIS, IR and GE were not correlated with FPG in impaired fasting plasma glucose obese elderly. Further study is needed for understating the underlying mechanisms.

KEYWORDS : type 2 diabetes, first phase insulin secretion, second phase insulin secretion, insulin resistance, glucose effectiveness

INTRODUCTION

Growing population and obesity have become a major public health problem worldwide. [1] Both aging and obesity have been linked to several comorbidities such as cardiovascular disease, type 2 diabetes, and certain cancers. [2-4] Organ function gradually decreases, ultimately disrupting homeostasis is the main role in aging. Overproduction of reactive oxygen species (ROS) affects both aging and obesity which linked the two senarios [5, 6] Obesity is an inflammatory condition in which inflammatory cytokines increase [7]. Likewise, mild chronic inflammation occurs frequently in older adults [8]. Aging is also referred to as "inflammation" because it is characterized by a constant increase in inflammatory conditions [9]. Levels of inflammatory markers such as C-reactive protein, interleukin-6, and tumor necrosis factor-α (TNF-α) in elderly obese adults were detected higher than younger adults [10, 11]. In both developed and developing countries, the relationship between aging an obesity is similar and studies appear to be more important at all ages. [12] The study of senile obesity and management is particularly relatively new entity. [12] Therefore, we focused on patients with impaired fasting blood glucose levels to see the baseline changes in insulin homeostasis. The current study seeks to explain the relationship between insulin secretion, insulin resistance, and glucose effects in obese elderly people.

METHODS

Study subjects

We randomly enrolled 31subjects who were aged 65 years old from Cardinal Tien hospital and Tri-Service general hospital in Taiwan. All these patients were obese (body mass index (BMI) ≥ 25 kg/m^2) and the fasting plasma glucose (FPG) was between 100 and 125 mg/dl. All study participants were anonymous and informed consent was obtained from all participants. Data were provided by these three facilities for research purpose only, and the institutional review board approved the study protocol. Participants who were on any medications known to affect blood pressure, glucose and lipids levels were excluded. The participants were further divided into two groups: with and without metabolic syndrome, according to the World Health Organization criteria. [13]. Finally, four diabetic factors including first phase insulin secretion (FPIS), second phase insulin secretion (SPIS), insulin resistance (IR) and glucose effectiveness (GE) were calculated.

On the day of the study, a senior nursing staff recorded the subject's medical history, including information on any current medications, and a physical examination was performed. Waist circumference was measured horizontally at the level of the natural waist. BMI was calculated as the subject's body weight (kg) divided by the square of the subject's height (m). Both systolic blood pressure and diastolic blood pressure were measured by standard mercury sphygmomanometers on the right arm of each subject while seated.

After fasting for 10 hours, blood samples were drawn for biochemical analyses. Plasma was separated from the blood within 1 hour of collection and stored at 30°C until analysis for FPG and lipid profiles. FPG was measured using a glucose oxidase method (YSI 203 glucose analyzer, Yellow Springs Instruments, Yellow Springs, USA). Total cholesterol and triglyceride levels were measured using a dry, multilayer analytical slide method with the Fuji Dri-Chem 3000 analyzer (Fuji Photo Film, Tokyo, Japan). Serum high-density lipoprotein cholesterol and low-density lipoprotein cholesterol concentrations were analyzed using an enzymatic cholesterol assay, following dextran sulfate precipitation.

STATISTICAL ANALYSES

All statistical analyses were performed using SPSS 23.0 (IBM Inc., Armonk, New York). Data are presented as mean ± standard deviation. All data were tested for normal distribution with the Kolmogorov–Smirnov test and for homogeneity of variances with Levene's test. If data were not normally distributed, data were log transformed prior to analysis. A t–test was performed to evaluate the differences between with and without metabolic syndrome groups. A simple correlation was applied to evaluate the relationship between two independent variables.

RESULTS

In the current study, we enrolled 18 male and 13 female subjects. All of them were aged 65 and obese (BMI ≥ 25 kg/m^2). The mean FPG was 108 (mg/dl) in both male and female. All the demographic data were non-significant when compared with male and female except the hemoglobin. These parameters included FPIS, SPIS, IR and GE (Table 1).

Table 1 Demographic data of the study subjects

	Male	Female	p
n	18	13	
Body mass index (kg/m^2)	26±0.3	27±0.3	0.738
Systolic blood pressure (mmHg)	137±16	141±15	0.481
Diastolic blood pressure (mmHg)	77±9	77±10	0.748
Fasting plasma glucose (mg/dl)	108±18	108±10	0.938
HDL-C (mmol/dl)	1.168±0.387	1.275±0.310	0.418
LDL-C (mmol/dl)	3.564±0.819	3.757±1.049	0.569
Triglyceride (mmol/dl)	1.662±0.725	1.941±0.864	0.337
Hemoglobin (10^3/μL)	14.9±0.8	13.5±0.9	<0.001
White blood cell count (10^3/μL)	7.122±1.758	6.569±1.888	0.409
Platelet count (10^3/μL)	237±73	238±50	0.945
GE (10^{-2} ·dL ·min^{-1} ·kg^{-1})	0.014±0.002	0.014±0.002	0.354
IR (10^{-4} ·min^{-1} ·pmol^{-1} ·L^{-1})	3.697±0.010	3.702±0.014	0.203
Log_FPIS (μU/min)	2.243±0.192	2.221±0.117	0.729
Log_SPIS (pmol/mmol)	-0.994±0.044	-1.022±0.053	0.130

HDL-C = High-density lipoprotein cholesterol; LDL-C = Low-density lipoprotein cholesterol; Log FPIS = Log transformation of first phase insulin secretion; Log SPIS = Log transformation of second phase insulin secretion; IR = Insulin resistance; GE = Glucose effectiveness.
Data shown are mean ± SD

Table 2 Correlation between fasting plasma glucose and four diabetic factors

	r	p
Male		
Log transformation of first phase insulin secretion	-0.258	0.300
Log transformation of second phase insulin secretion	-0.884	<0.001
Insulin resistance	-0.034	0.894
Glucose effectiveness	-0.392	0.108
Female		
Log transformation of first phase insulin secretion	-0.384	0.218
Log transformation of second phase insulin secretion	-0.910	<0.001
Insulin resistance	0.077	0.804
Glucose effectiveness	-0.301	0.318

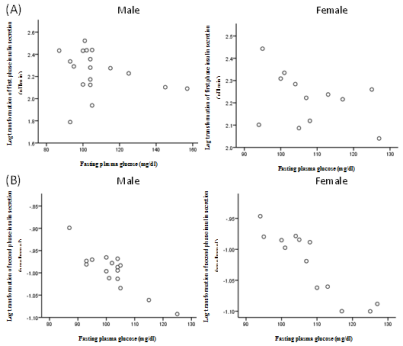

Figure 1 Scatter plot of first and second phase insulin secretion and fasting plasma glucose

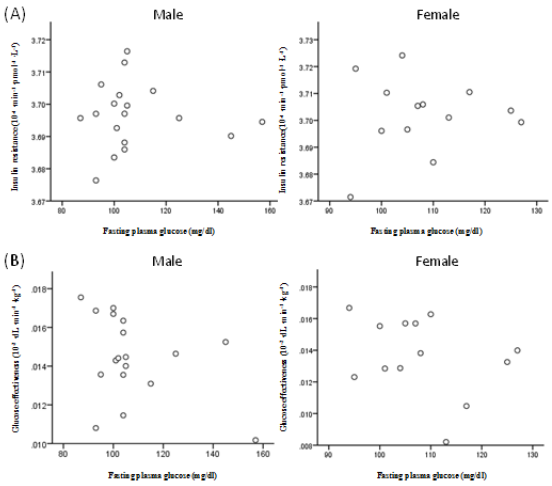

Figure 2 Scatter plot of insulin resistance, glucose effectiveness and fasting plasma glucose

When we compared these four diabetic factors with FPG, we found only SPIS was significantly negative correlated with FPG in both genders Table 2. In the figure 1 and 2 we demonstrated the correlation plot of FPG and four different diabetic factors.

DISCUSSION

Obesity is not always associated with insulin resistance. However, most people with insulin resistance will be obese or overweight [14, 15]. Therefore, obesity is a fundamental risk factor for developing insulin resistance. Obesity, dysfunction of the lipid organs, and among the possible causes of metabolic disorders due to changes in fat metabolism have a clear fundamental role [16, 17]. This is due to imbalanced ROS production, antioxidant protection and fat-free chronic inflammation. Tissue is also an important control for insulin sensitivity [18-20]. Increased inflammation can be enhanced by excessive ROS and can have a direct effect on insulin signaling in insulin target tissues [18, 19, 21-23], a systematic complex network of nutrients and nutrients. Intestinal microbial reactions also play an important role in regulating substrate utilization and balance.

Adipose tissue is an important metabolic organ that stores excess nutrients as triacylglycerides, releases fatty acids on an empty stomach, and acts as an energy source for peripheral tissues in a state of homeostasis. Fat is dominated by macrophages and regulates fat cell fat metabolism by secretory factors. Interleukin 10 and catecholamine, increases insulin sensitivity, adipocytes and adipogenesis [26], while catecholamine induces adipocyte lipolysis. [27] Obesity contributes to insulin resistance, in this process, immune cells mainly penetrate white adipose tissue and metabolic organs such as the liver and are released into the circulation. Obesity's cytokine levels do not reach those at the time of infection. The most studied inflammatory factors in obesity were TNFα, interleukin 6, interleukin 17, and CCL-2 [28].

Human glucose tolerance tests rely on the complex interaction of insulin secretion, IR and GE activity in impaired glucose tolerance. Anomalies in one component are compensated for by the more participation of the other component. [29] Research shows that GE plays an important role in the future progression of type 2 diabetes. [30, 31] There is evidence that several brain neuronal regions play a role in glucose balance [32-34], it has been hypothesized that GLP-1 increases GE through the action of increasing insulin secretion. [35, 36] Glucagon is known to have a significant effect on GE. DeFronzo et al. [37] conducted a study on the effect of hyperglycemia on euglycemia in healthy people.

Hyperglycemia inhibits the production of endogenous glucose production by 74% when somatostatin injections suppress the secretion of insulin and glucose-regulating hormones. These results indicate that hyperglycemia and hypoglycemia may play a role in inhibiting glucose production in non-diabetic people [37]

Chronic mild inflammation under hyperlipidemia is known to play an important role in the development of lipotoxicity and pancreatic cell abnormalities [38, 39]. The normalization of -cells induced by hyperlipidemia has not yet been fully investigated. Adipokine, an proposed contributing factor for diabetes, Romere et al. found that obesity and diet improved the expression of androsine in adipose tissue [40]. Basal hyperinsulinemia is mainly due to weight related increase of insulin secretion with moderate contribution of reduced insulin clearance. Postprandially, hyperinsulinemia of overweight is predominantly due to secretion while further postprandial hyperinsulinemia of obese subjects is mainly due to reduced clearance. Therefore, postprandial insulin secretion does not adequately solve the weight-dependent insulin resistance problem in obese patients without diabetes [41].

In conclusion, FPG was correlated with SPIS only. FPIS, IR and GE were not correlated with FPG in impaired fasting plasma glucose obese elderly. Further study is needed for understating the underlying mechanisms.

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