Analysis of the Correlation Between Visceral Fat Area and Insulin Resistance in Patients with Type 2 Diabetes and Abdominal Obesity

Guohui Zhang, Juan Xu, Qiong Peng, Yalei Xu, Shaochang Ma*

Guandu People's Hospital of Kunming, Kunming 650200, China

Corresponding author: Shaochang Ma, zhangguohui777@gmail.com

Abstract: *Objective:* To analyze the correlation between visceral fat area and insulin resistance index (HOMA-IR) in patients with type 2 diabetes mellitus (T2DM) and abdominal obesity and to provide a reference for screening and related research of such patients. *Methods:* Two hundred patients with T2DM admitted to Guandu People's Hospital of Kunming were included. The study was carried out from October 2022 to December 2023. The patients were divided into three groups according to different abdominal visceral fat areas (VFA): Group A ($n = 65$) was less than 75cm^2, Group B ($n = 75$) was 75–100 cm^2, and Group C ($n = 60$) was greater than 100 cm^2. The subjects in the three groups were all tested for glycated hemoglobin (HbA1c), fasting insulin (FINS), and fasting blood glucose (FPG). Height and weight were measured to calculate body mass index (BMI). The HOMA-IR and TYG (fasting triglyceride and glycemic index) were also calculated. Changes in the BMI, VFA, HOMA-IR, and TYG levels were observed in the three groups. *Results:* The VFA, BMI, HbA1c, FPG, FINS, HOMA-IR, and TYG of the patients all increased, with a more significant increase in the BMI, FINS, HOMA-IR, and TYG levels ($P < 0.01$). Multiple linear stepwise regression analyses used visceral fat area (VFA) as the dependent variable. The results showed that VFA was closely related to BMI, FINS, HOMA-IR, and TYG. *Conclusion:* Early reduction of VFA to reduce insulin resistance may be a better treatment and effective method for T2DM, providing powerful measures and new strategies for effective blood sugar control and early prevention in the treatment of metabolic diseases.

Keywords: Type 2 diabetes; Abdominal obesity; Visceral fat area; Insulin resistance

1. Introduction

The incidence of type 2 diabetes (T2DM) is increasing year by year and is expected to reach 783 million by 2045. There are reports on the relationship between insulin resistance and abdominal visceral fat in patients with newly diagnosed T2DM. Still, the population is relatively limited and is confined to male patients with abdominal obesity [1]. Insulin resistance is caused by the body's ineffective utilization of insulin, resulting in increased insulin. The insulin resistance index (homeostatic model assessment for insulin resistance, HOMA-

IR) describes the degree of insulin resistance [2,3]. This study analyzes the correlation between the visceral fat area (VFA) and HOMA-IR in patients with T2DM and abdominal obesity. This study included 200 patients with T2DM who were admitted to the Guandu People's Hospital of Kunming from October 2022 to December 2023.

2. Objects and methods

2.1. Research objects

Two hundred patients with T2DM admitted to the Guandu People's Hospital of Kunming were selected. The study was carried out from October 2022 to December 2023. The venous fasting blood glucose (FPG) of the patients was 3.9–6.1 mmol/L and their blood pressure was within the normal range. The imported body composition analyzer measured the subjects' VFA in Groups A, B, and C and the patients were divided into three groups according to their VFA. Group A consisted of 65 subjects with a VFA value less than 75 cm^2, Group B consisted of 75 subjects with a VFA value between 75–100 cm^2, and Group C consisted of 60 subjects with a VFA value greater than 100 cm^2. The basic information of the 3 groups of patients was comparable and yielded no significant difference ($P > 0.05$). This study was approved by the Ethics Committee of Guandu People's Hospital of Kunming.

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) Patients aged 25–80 years old; (2) patients diagnosed with T2DM; (3) patients who are not shy about their height and weight; (4) cooperated and consented. Exclusion criteria: (1) Patients with excessive fasting insulin (FINS) of greater than 11.1 mmol/L; (2) severe complications of diabetes; (3) unable to communicate properly; (4) pregnant; (5) patients with serious organ diseases.

2.3. Method

The subjects in all 3 groups were tested for glycated hemoglobin (HbA1c), FINS, and FPG. All the subjects' height and weight were measured, including their body mass index (BMI), HOMA-IR, and TYG (fasting triglyceride and glycemic index). The changes in BMI, VFA, HOMA-IR, and TYG levels in the three groups were observed and compared.

2.4. Statistical analysis

The SPSS 22.0 statistical software was used for statistical analysis. Measurement data were expressed as mean ± standard deviation and compared using a t-test. Count data were analyzed using the chi-squared (χ^2) test or Fisher's exact analysis method. A logistic regression model was used to analyze the influencing factors of the VFA in T2DM patients and abdominal obesity. Results were considered statistically significant at $P < 0.05$.

3. Results

3.1. Comparison of VFA results among the three groups of patients

An imported body composition analyzer was used to measure the abdominal VFA of all patients. As shown in **Table 1**, the VFA of Group A was less than 75 cm^2, the VFA of Group B was 75–100 cm^2, and the VFA of Group C was greater than 100 cm^2. The differences between the three groups of patients were statistically significant ($P < 0.05$).

Table 1. Comparison of VFA results among three groups of patients

Group	Cases, *n*	VFA (cm^2)
Group A	65	71.25 ± 3.48
Group B	75	89.56 ± 5.23
Group C	60	117.05 ± 8.92
F		21.207
P		0.000

3.2. Comparison of various indicators of different VFA patients with HOMA-IR and TYG

The HbA1c, FINS, and FPG in different VFA patients were measured. The patient's height and weight were measured, and their BMI, HOMA-IR, and TYG were calculated. As shown in **Table 2**, as the VFA value increases, the patient's BMI, HbA1c, FPG, FINS, HOMA-IR, and TYG increased, with a greater increase in BMI, FINS, HOMA-IR, and TYG ($P < 0.01$).

Table 2. Comparison of various indicators in different VFA patients with HOMA-IR and TYG

Index	Group A (*n* = 65)	Group B (*n* = 75)	Group C (*n* = 60)	F	*P*
Age (years)	51.39 ± 6.72	49.86 ± 7.08	50.96 ± 6.95	0.983	0.425
BMI (kg/m^2)	22.95 ± 2.84	24.34 ± 3.16	27.72 ± 3.63	18.926	0.000
HbA1c (%)	6.48 ± 0.47	6.72 ± 0.56	6.83 ± 0.57	2.453	0.295
FPG (mmol/L)	6.36 ± 1.97	6.65 ± 2.05	6.73 ± 2.14	3.827	0.116
FINS (mIU/L)	7.32 ± 1.15	8.21 ± 1.63	9.74 ± 2.26	15.625	0,000
HOMA-IR	7.24 ± 1.68	8.45 ± 1.87	9.08 ± 1.56	9.392	0.001
TYG	8.79 ± 0.62	9.03 ± 0.49	9.84 ± 0.59	8.338	0.002

3.3. Linear regression analysis between VFA and BMI, FINS, HOMA-IR, and TYG

Multiple linear stepwise regression analyses used VFA as the dependent variable. As shown in Table 3, VFA was closely related to BMI, FINS, HOMA-IR, and TYG.

Table 3. Linear regression analysis between VFA and BMI, FINS, HOMA-IR, and TYG

Index	β	CLAIM.	Wald χ^2	PS	OR	95% CI
BMI	0.354	0.083	12.882	0.000	1.402	1.135–1.6
FINS	0.142	0.046	10.653	0.000	1.153	1.038–1.3
HOMA-IR	0.067	0.035	7.836	0.001	1.084	1.019–1.1
TYG	1.396	0.475	8.932	0.002	1.386	1.124 1.798

Abbreviation: Practical significance, PS; odds ratio, OR; confidence interval, CI.

4. Discussion

Due to lifestyle and dietary habit shifts, the prevalence of overweight/obesity is on the rise worldwide and has now developed into a serious public health problem [4–6]. Excess visceral fat is a manifestation of metabolic di-

sorders in the body. Long-term accumulation of visceral fat can lead to complications such as hyperlipidemia, cardiovascular and cerebrovascular diseases, and decreased body organ function [7]. Obesity is the main component of metabolic syndrome and a key factor in promoting T2DM and cardiovascular disease. It can also result in hypertension and lipid metabolism disorders [8,9]. T2DM is the most common endocrine disorder and has become humanity's primary health threat. Changes in dietary structure, lack of exercise, and sedentary lifestyles have caused obesity, especially abdominal obesity, to coexist with T2DM. Relevant studies have shown that catabolism was highly active when excess abdominal visceral fat and free fatty acids were produced. Instead of being stored in the adipose tissue, free fatty acids enter the blood and are eventually deposited ectopically in the liver or skeletal muscles [10]. This induces insulin resistance in the liver and skeletal muscles. Eventually, diabetes occurs as the body is insensitive to the blood sugar-lowering effects of insulin [11]. Insulin resistance is a common pathophysiological characteristic of patients with abdominal obesity and T2DM. Increased intra-abdominal fat is the main cause of insulin resistance, indicating that obesity, to a certain extent, is accompanied by an increase in waist circumference (the occurrence of abdominal obesity), leading to T2DM [12].

At present, there is some research on the relationship between insulin resistance and abdominal visceral fat in T2DM patients. This study analyzed the relationship between insulin resistance and abdominal VFA in patients with newly diagnosed T2DM and abdominal obesity and explored its correlation with various metabolic indicators. The levels of HbA1c, FINS, and FPG in patients with different VFA were measured, along with their height and weight. Changes in the BMI, HOMA-IR, and TYG in the 3 groups were also observed. This study showed that as the VFA value increases, the patient's BMI, HbA1c, FPG, FINS, HOMA-IR, and TYG all increased, with a greater increase in BMI, FINS, HOMA-IR, and TYG levels. The results also showed that reducing abdominal and visceral fat areas alleviated T2DM comorbidities. Insulin resistance and TG are of great significance in patients with abdominal obesity. The main reason is due to the increase in weight. Thickening and increase of visceral fat directly affects glucose metabolism, which in turn affects insulin resistance. This study conducted multiple linear stepwise regression analyses using VFA as the dependent variable and showed that VFA was closely related to BMI, FINS, HOMA-IR, and TYG, indicating that the visceral fat area in patients with T2DM and abdominal obesity were positively correlated with insulin resistance. Furthermore, changes in VFA directly affected the patient's insulin resistance, thereby affecting their insulin function.

5. Conclusion

Reducing insulin resistance by reducing VFA early may be an effective method to promote the recovery of insulin function in patients with T2DM and abdominal obesity. This also provides insights into new methods and strategies for effective blood sugar control and early prevention in the treatment of metabolic diseases.

Disclosure statement

The authors declare no conflict of interest.

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