Predicting Value of Perirenal Fat Thickness for Metabolic Syndrome in Patients with Newly-Diagnosed Type 2 Diabetes

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Research Article

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Abstract

Objective

Increasing evidences suggested that perirenal fat thickness (PrFT) was associated with metabolic risk factors, this study aimed to assess the association between PrFT with components of metabolic syndrome (MetS) and explore the value of PrFT in predicting MetS among Newly-Diagnosed type 2 diabetes(T2DM).

Method

A total of 445 patients with Newly-Diagnosed T2DM from southern China were enrolled into this study. Demographic and anthropometric information were collected. PrFT was evaluated by CT scanning on Revolution VCT 64. Binomial logistic regression analysis and receiver operating characteristics (ROC) curves were conducted to assess the value and optimal cutoff of PrFT for predicting MetS divided by sex.

Results

The prevalence of MetS was 58.2% in Newly-Diagnosed T2DM. Correlation analysis showed that PrFT was significantly correlated with metabolic risk factors (BMI, WC, TG, HDL-c, SBP, DBP, UA and HOMA-IR). PrFT was also shown to be independently associated with MetS after adjustment for other confounders, the ORs(95%CI) were 1.33(1.01~1.74) in men and 1.53(1.08~2.17) in women($P<0.05$). ROC curves showed a good predictive value of PrFT for MetS, the the areas under the curve of ROC values of PrFT predicting MetS were 0.895(95% CI 0.852~0.939) in men and 0.910(95% CI 0.876~0.953) in women($P<0.001$). The optimal cut-off values of PrFT were 14.6 mm (sensitivity: 83.8%, specificity: 89.6%) for men and 13.1 mm (sensitivity: 87.6%, specificity: 91.1%) for women.

Conclusions

PrFT was significantly independent with MetS and showed a powerful predictive value for MetS, which suggested PrFT could be a potential indicator to help clinicians to screen high-risk groups in Newly-Diagnosed T2DM.

Clinical Trial Registration:

This study was registered in Clinical Trials. Gov (ChiCTR2100052032).

Introduction

Metabolic syndrome (MetS) is the common pathological basis and early stage of many major diseases, which characterized by the simultaneous presence of obesity, hypertension, dyslipidemia and hyperglycemia in individuals, leading to increased cardiovascular disease (CVD), stroke and diabetes risk^[1]. Type 2 Diabetes (T2DM) is a metabolic disease characterized by chronic hyperglycemia due to the failure of pancreatic islet β -cells to sustain the hyperinsulinemia required to compensate for insulin resistance, and often accompanied with other metabolic disorders. The prevalence of MetS has rapidly increased in China, Cross-Sectional Survey reported the prevalence of MetS in diabetes is range from 53–68.1%^[2]. Due to the great harm and high prevalence of MetS in patient with Newly-Diagnosed T2DM, the early diagnosis is urgently needed, while the diagnosis and awareness rate are suboptimal in clinical diagnosis and treatment^[3]. The diagnostic process for MetS in patient with diabetes is cumbersome that may limit the early diagnosis of MetS. An effective and appreciable risk predictor of MetS can help clinicians focus on screening high-risk groups in patient with Newly-Diagnosed T2DM.

Visceral adipose tissue (VAT) is considered to be a type of "ectopic fat", which has adverse influences on systemic inflammation, insulin resistance and metabolic profiles, and finally increasing the risk of developing MetS and CVD^[4–6]. Among visceral adipose tissue deposits, perirenal fat is located around and enclosed from the inner side of abdominal musculature to the surface of the kidney, which can be easily measured under ultrasound, CT and MRI scanning. Anatomical studies have demonstrated that perirenal fat is unique compared to other connective tissues because of its good vascular supply and flow to the lymphatic system. Thus, perirenal fat can modulate the metabolism system through neural reflexes, adipokine secretion, and adipocytes interactions^[8–10], these features may provide a basis for the involvement of perirenal fat in MetS regulation. Cross-sectional studies had also observed that PrFT is associated with the components of MetS, such as hypertension, obesity and dyslipidemia^[11, 12]. Based on the above anatomical and cross-sectional studies, it may indicate us that PrFT can be a reliable risk predictor for MetS in Newly-Diagnosed T2DM. Hence, we design a cross-sectional study to assess the association between PrFT with metabolic risk factors among Newly-Diagnosed T2DM, and further exploring the value of PrFT in predicting MetS among Newly-Diagnosed T2DM.

Study Design And Methods

Study design and participants

This Cross-Sectional study was conducted with individuals from the Department of Endocrinology at the Longyan First Affiliated Hospital of Fujian Medical University who fulfilled the study criteria between January 2021 and June 2021. Study inclusion criteria were as follows: 1) Newly diagnosis of diabetes using the World Health Organization (WHO) 2019 criteria; 2) Autoimmune antibodies (GADA, IAA, ICA) negative. Participants were excluded if they were the following: 1) Pregnancy at diagnosis or gestational diabetes mellitus (GDM); 2) Secondary or special type of diabetes; 3) Presence of acute diseases that could interfere the glucose metabolism; 4) With renal structure abnormalities (tumors and cysts or history of renal region surgery); 5) Currently receiving lipid-lowering therapies; Assessment of metabolic and

hormonal parameters, Demographic and anthropometric information were evaluated. And then, all participants were performed with CT scanning to measure PrFT. All procedures were conducted in accordance with Declaration of Helsinki, and this study was approved by the Ethical Committee of Longyan First Affiliated Hospital of Fujian Medical University (LY-2020-069) and registered in Clinical Trials. Gov (ChiCTR2100052032). All participants enrolled into the study provided informed consent.

Definition of Metabolic Syndrome

MetS was defined according to the Chinese guideline for diabetes with Mets management^[13], patients who meet three or more of the following criteria were considered to have MetS: (1) Abdominal obesity: waist circumference ≥ 90 cm in men and ≥ 85 cm in women; (2) Hyperglycemia: fasting blood glucose ≥ 6.1 mmol/L or (OGTT) 2h-blood glucose ≥ 7.8 mmol/L or previously diagnosed diabetes with treatment; (3) Hypertension: blood pressure $\geq 130/85$ mmHg or currently under anti-hypertension therapy; (4) Fasting triglycerides (TGs) ≥ 1.70 mmol/L (Without lipid-lowering therapies); (5) Fasting high-density lipoprotein cholesterol (HDL-c) ≤ 1.04 mmol/L. All patients in this study fulfilled with the criteria for hyperglycemia and diagnosed as Newly-Diagnosed T2DM.

Anthropometric measurements and metabolic parameters

Demographic information was collected through a standard questionnaire via face-to-face interviews by a physician (mainly including gender, age, history of medication ,disease ,surgery and smoking).All patients enrolled into this study underwent physical examination by the research nurses(including height, weight, WC and blood pressure).BMI was calculated as the weight (kg rounded to the nearest kg) divided by the square of height (m rounded to the nearest centimeter).WC was measured at the anatomical waist(the natural depression between the iliac crest and 10th rib), which should be the narrowest part of the abdomen. Systolic and diastolic blood pressure were recorded on at least three different occasions by an electronic sphygmomanometer with an appropriate cuff size after patients rest more than 5 minutes.

Serum fasting blood glucose(FBG),insulin, glycosylated hemoglobin (HbA1c), autoimmune antibodies(GADA,IAA,ICA),total cholesterol(TC),high-density lipoprotein(HDL-c) ,low-density lipoprotein cholesterol (LDL-c), triglycerides(TG), Uric acid (UA) and high-sensitivity C-reactive protein (hs-CRP) were measured by standard methods using fasting venous blood samples ,which were taken between 8 and 9 am after fasting overnight at least 12 h. Homeostasis model assessment (HOMAIR) was used to assess the insulin resistance, the estimate of HOMA score was calculated with the formula: fasting serum insulin (μ U/ml) fasting plasma glucose (mmol/l)/22.5^[14].

Measurement of perirenal fat thickness

All patients enrolled into this study were performed with CT scanning on Revolution VCT 64 (General Electric, Milwaukee, USA) in a supine position to measure perirenal fat thickness. Image were reconstructed with Advantage Windows 4.4 software (GE, Milwaukee, USA) to obtain 1.25-mm-thick consecutive slices. CT scanning area covered between the pubic symphysis and the 10th thoracic vertebra. Perirenal fat was differentiated from other tissues by density (HU) The center of the window is

set in -100 HU and window widths ranging from 50 to 200 HU for further analysis. The Each compartment is drawn by using a manually controlled trackball cursor. PrFT was measured on both sides for each patient. The maximal distance between the posterior wall of the kidney and the inner limit of the abdominal wall across the renal venous plane. Two radiologists were involved the measurements of PrFT to reduce inter-operator variability. The average of the maximal thickness values on both kidneys were defined as the PrFT.

Statistical analysis

Data were analyzed by using the SPSS 23.0 software (SPSS Inc. IBM). Descriptive data are expressed as means $\pm$ standard deviation (SD), Skewed variables were given as a median and interquartile range. Discrete variables were summarized in frequency tables (N, %). The patients enrolled into this study were divided into three groups based on tertiles of PrFT. Statistical differences among groups were performed with one-way analysis of variance (ANOVA) followed by Turkey test for multiple comparisons. The chi-squared (χ^2) test or Fisher exact test were used for comparison of categorical variables. The relationship between PrFT and metabolic parameters was assessed using Pearson or Spearman correlation analysis. Binomial logistic regression analysis was used to estimate the independent predictors of MetS after adjusting for other confounders divided by sex. The receiver operating characteristic (ROC) curves were used to identify the predicting value of PrFT for MetS in Newly-Diagnosed T2DM. The optimal cut-off value was based on the greatest value of the Youden Index. A two-tailed value of $P < 0.05$ was considered statistically significant.

Results

A total of 470 patients were screened, and 445 patients meeting the inclusion and exclusion criteria were enrolled into this study, the flow diagram of excluded and included patients was present in Figure 2. Among the 445 patients, 226(50.7%) patients were man, the mean age of patients was 53.3 ± 7.9 years, the mean PrFT of patients was 12.8 ± 4.8 mm. The prevalence of patients with MetS was 58.2%, 57.5% in men and 58.9% in women separately. Due to the significant difference of mean PrFT between men and women (13.3 ± 5.1 mm vs 12.2 ± 4.3 mm, $P < 0.001$), the characteristics of patients enrolled into this study were divided into three groups based on tertiles of PrFT in men and women. As shown in Table 1 and Table 2, there were significant difference in BMI, WC, TG, HDL-c, LDL-c, APOB, UA, SBP, DBP and HOMA-IR among groups in men and women ($P < 0.05$). Patients in higher PrFT groups showed higher level of BMI, WC, TG, UA, SBP, DBP, HOMA-IR and lower level of HDL-c compared with lower PrFT groups in men and women ($P < 0.05$). Moreover, patients in higher PrFT groups showed more patients had MetS and hypertension both in men and women ($P < 0.05$).

Table 1

Characteristics of patients with Newly-Diagnosed T2DM were divided into three groups based on tertiles of PrFT in man.

	Total	T1 (<10.7mm)	T2 (10.7~16.1mm)	T3 (>16.1mm)	<i>P</i>
Age(year)	52.5±8.2	52.4±8.9	52.3±7.7	52.8±8.1	0.618
WC(cm)	86.6±7.0	80.3±3.3	86.9±4.8 ^{ab}	92.4±6.4 ^{bc}	<0.001
BMI(kg/m ²)	24.8±3.1	22.0±1.9	25.0±1.9 ^{ab}	27.2±2.9 ^{bc}	<0.001
HbA1c(%)	8.8±0.9	8.8±1.0	8.7±0.8	8.9±0.9	0.327
TG(mmol/L)	2.3±1.5	1.5±1.0	2.0±0.7 ^{ab}	3.3±1.9 ^{bc}	<0.001
TC(mmol/L)	5.4±1.3	5.1±1.1	5.5±1.4 ^a	5.6±1.2 ^b	0.026
HDL-c(mmol/L)	1.1±0.2	1.3±0.2	1.1±0.1 ^{ab}	0.9±0.1 ^{bc}	<0.001
LDL-c(mmol/L)	3.6±1.0	3.4±0.9	3.8±1.1 ^a	3.7±0.9 ^b	0.014
APOA(g/L)	1.3±0.3	1.4±0.2	1.3±0.2 ^a	1.2±0.3 ^b	0.003
APOB(g/L)	1.1±0.3	1.0±0.3	1.1±0.3 ^a	1.1±0.3 ^b	0.018
UA(umol/L)	360.4±86.2	307.5±60.1	372.4±77.2 ^{ab}	401.4±90.5 ^{bc}	<0.001
SBP(mmHg)	134.3±18.4	119.1±11.4	137.2±10.2 ^{ab}	146.1±19.4 ^{bc}	<0.001
DBP(mmHg)	82.5±10.3	76.6±6.1	83.4±12.2 ^{ab}	87.5±7.2 ^{bc}	<0.001
HOMA-IR	11.5±6.5	6.3±3.7	12.4±4.7 ^{ab}	15.6±6.8 ^{bc}	<0.001
hs-CRP(mg/L)	3.4±1.1	3.3±0.9	3.4±1.0	3.5±0.9	0.218
Hypertension, n(%)	84(37.2)	9(12.0)	27(36.5) ^{ab}	48(62.3) ^{bc}	<0.001
Smoking, n(%)	120(53.1)	38(50.7)	40(54.1)	42(54.5)	0.683
MetS, n(%)	130(57.5)	11(14.7)	24(32.4) ^{ab}	69(89.6) ^{bc}	<0.001
BMI: body mass index; WC: waist circumference. HbA1c: Glycated hemoglobin. UA: uric acid. TG: triglyceride. TC: total cholesterol. HDL-c: high-density lipoprotein cholesterol. LDL-c: Low density lipoprotein cholesterol. SBP: Systolic blood pressure. DBP: Diastolic blood pressure. HOMR-IR: Homeostasis model assessment insulin resistance. hs-CRP: High sensitivity C-reactive protein; MetS: Metabolic syndrome. ^a <i>P</i> <0.05: T1 vs T2. ^b <i>P</i> <0.05: T1 vs T3. ^c <i>P</i> <0.05: T2 vs T3.					

Table 2

Characteristics of patients with Newly-Diagnosed T2DM were divided into three groups based on tertiles of PrFT in women.

	Total	T1 (<10.2mm)	T2 (10.2~14.9mm)	T3 (>14.9mm)	<i>P</i>
Age(year)	54.2±7.5	53.5±7.7	54.1±7.5	54.8±7.3	0.569
WC(cm)	85.1±6.7	80.4±3.8	84.6±5.0 ^{ab}	90.2±6.8 ^{bc}	<0.001
BMI(kg/m ²)	24.2±2.9	22.1±2.1	24.1±2.2 ^{ab}	26.3±2.6 ^{bc}	<0.001
HbA1c(%)	8.7±1.0	8.7±1.1	8.8±0.9	8.7±1.0	0.624
TG(mmol/L)	2.0±1.1	1.3±0.5	1.8±0.6 ^{ab}	2.9±1.3 ^{bc}	<0.001
TC(mmol/L)	5.1±1.1	4.9±1.1	5.2±1.2	5.2±1.0 ^b	0.089
HDL-c(mmol/L)	1.1±0.2	1.3±0.2	1.1±0.2 ^{ab}	0.9±0.2 ^{bc}	<0.001
LDL-c(mmol/L)	3.4±0.9	3.1±0.8	3.6±0.9 ^a	3.5±1.0 ^b	0.001
APOA(g/L)	1.3±0.3	1.3±0.3	1.3±0.2	1.2±0.3	0.519
APOB(g/L)	1.0±0.3	0.9±0.3	1.0±0.3 ^a	1.0±0.3 ^b	0.001
UA(umol/L)	348.9±86.8	281.8±62.3	352.5±66.3 ^{ab}	411.5±76.8 ^{bc}	<0.001
SBP(mmHg)	132.3±16.6	119.5±12.2	132.6±16.6 ^{ab}	144.6±9.7 ^{bc}	<0.001
DBP(mmHg)	81.0±88.0	74.6±5.7	82.0±9.4 ^{ab}	86.5±6.5 ^{bc}	<0.001
HOMA-IR	10.7±5.4	6.5±3.7	11.4±4.3 ^{ab}	14.0±5.1 ^{bc}	<0.001
hs-CRP(mg/L)	2.9±0.8	3.0±0.9	2.8±1.2	2.8±0.9	0.692
Hypertension, n(%)	81(37.0)	11(15.1)	24(33.3) ^{ab}	46(62.2) ^{bc}	<0.001
Smoking, n(%)	6(2.7)	3(4.1)	3(4.2)	0(0)	0.207
MetS, n(%)	129(58.9)	9(12.3)	50(69.4) ^{ab}	70(94.6) ^{bc}	<0.001
BMI: body mass index; WC: waist circumference. HbA1c: Glycated hemoglobin. UA: uric acid. TG: triglyceride. TC: total cholesterol. HDL-c: high-density lipoprotein cholesterol. LDL-c: Low density lipoprotein cholesterol. SBP: Systolic blood pressure. DBP: Diastolic blood pressure. HOMR-IR: Homeostasis model assessment insulin resistance. hs-CRP: High sensitivity C-reactive protein; MetS: Metabolic syndrome. ^a <i>P</i> <0.05: T1 vs T2. ^b <i>P</i> <0.05: T1 vs T3. ^c <i>P</i> <0.05: T2 vs T3.					

The main correlations between metabolic parameters and PrFT in the subgroup divided by sex were presented in Table 3. The results showed that PrFT was significantly and positively correlated with WC

($R = 0.770$, $P < 0.001$), BMI ($R = 0.779$, $P < 0.001$), TG ($R = 0.602$, $P < 0.001$), LDL-c ($R = 0.156$, $P = 0.019$), UA ($R = 0.494$, $P < 0.001$), SBP ($R = 0.695$, $P < 0.001$), DBP ($R = 0.538$, $P < 0.001$) and HOMA-IR ($R = 0.688$, $P < 0.001$) in men group, and WC ($R = 0.674$, $P < 0.001$), BMI ($R = 0.690$, $P < 0.001$), TG ($R = 0.726$, $P < 0.001$), LDL-c ($R = 0.190$, $P = 0.005$), UA ($R = 0.665$, $P < 0.001$), SBP ($R = 0.713$, $P < 0.001$), DBP ($R = 0.611$, $P < 0.001$) and HOMA-IR ($R = 0.656$, $P < 0.001$) in women group. Moreover, PrFT was significantly and negatively correlated with HDL-c ($R = -0.592$, $P < 0.001$) in men group and HDL-c ($R = -0.507$, $P < 0.001$) in women group.

Table 3

Main correlations between metabolic parameters and PrFT in patients with Newly-Diagnosed T2DM divided by sex.

Parameter	Men(n=226)		Women(n=219)	
	R	P	R	P
WC(cm)	0.770	<0.001	0.674	<0.001
BMI(kg/m ²)	0.779	<0.001	0.690	<0.001
TG(mmol/L)	0.602	<0.001	0.726	<0.001
TC(mmol/L)	0.128	0.068	0.131	0.051
LDL-c(mmol/L)	0.156	0.019	0.190	0.005
HDL-c(mmol/L)	-0.592	<0.001	-0.507	<0.001
UA(umol/L)	0.494	<0.001	0.665	<0.001
SBP(mmHg)	0.695	<0.001	0.713	<0.001
DBP(mmHg)	0.538	<0.001	0.611	<0.001
HOMA-IR	0.688	<0.001	0.656	<0.001
BMI: body mass index; WC: waist circumference. TG: triglyceride; TC: total cholesterol. HDL-c: high-density lipoprotein cholesterol. LDL-c: Low density lipoprotein cholesterol. UA: uric acid. SBP: Systolic blood pressure. DBP: Diastolic blood pressure. HOMR-IR: Homeostasis model assessment insulin resistance.				

The associations between MetS and PrFT were further investigated by binomial logistic regression analysis in patients with Newly-Diagnosed T2DM divided by sex (Table 4). The PrFT was shown to be independently associated with MetS after adjustment for Age, HbA1c and Smoking (Model 1), the ORs(95%CI) were 1.53(1.38~1.70) in men and 1.66(1.47~1.88) in women. After further adjustment for BMI, TC, LDL-c, APOA, APOB, UA, HOMA-IR, and hs-CRP (Model 2), the PrFT was shown to be independently associated with MetS, the ORs(95%CI) were 1.32(1.13~1.54) in men and 1.53(1.27~1.83) in women. After further additional adjustment for TG, WC, HDL-c, SBP and DBP (Model 3), the ORs did not substantially change, the ORs(95%CI) were 1.33(1.01~1.74) in men and 1.53(1.08~2.17) in women($P < 0.05$).

Table 4
Binomial Logistic Regression Analysis adjusted ORs (95% CIs) of PrFT in patients with Newly-Diagnosed T2DM divided by sex.

Parameter	Men(n=226)	Women(n=219)		
	OR(95%CI)	P	OR(95%CI)	P
Model 1	1.53(1.38~1.70)	<0.001	1.66(1.47~1.88)	<0.001
Model 2	1.32(1.13~1.54)	<0.001	1.53(1.27~1.83)	<0.001
Model 3	1.33(1.01~1.74)	0.043	1.53(1.08~2.17)	0.017
Model 1: adjusted for Age, HbA1c and Smoking. Model 2: adjusted for BMI, TC, LDL-C, APOA, APOB, UA, HOMA-IR, and hs-CRP. Model 3: additional adjusted for TG, WC, HDL-c, SBP and DBP. BMI: body mass index; WC: waist circumference. HbA1c: Glycated hemoglobin. UA: uric acid. TG: triglyceride. TC: total cholesterol. HDL-c: high-density lipoprotein cholesterol. LDL-c: Low density lipoprotein cholesterol. SBP: Systolic blood pressure. DBP: Diastolic blood pressure. HOMR-IR: Homeostasis model assessment insulin resistance. hs-CRP: High sensitivity C-reactive protein; MetS: Metabolic syndrome.				

The ROC curve analysis was used to further analyzing the predicting value of PrFT for MetS in patients with Newly-Diagnosed T2DM divided by sex. From the ROC curve analysis, the results showed a good predictive value of PrFT for MetS, the areas under the curve of ROC values of PrFT predicting MetS were 0.895(95% CI 0.852~0.939, $P<0.001$) in men and 0.910(95% CI 0.876~0.953, $P<0.001$) in women (Figure 3). The optimal cut-off values of PrFT were 14.6 mm (sensitivity: 83.8%, specificity: 89.6%) for men and 13.1 mm (sensitivity: 87.6%, specificity: 91.1%) for women (Table 5).

Table 5
ROC Curve Analysis of PrFT in Predicting MetS in patients with Newly-Diagnosed T2DM divided by sex.

Variables	AUC(95% CI)	Cut-Off value	Sensitivity (%)	Specificity (%)
Men(n=226)				
PrFT	0.895(0.852~0.939)	14.6	83.8	89.6
Women(n=219)				
PrFT	0.910(0.876~0.953)	13.1	87.6	91.1
MetS: Metabolic syndrome. PrFT: Perirenal fat thickness.				

Discussion

Type 2 Diabetes (T2DM) is a metabolic disease characterized by chronic hyperglycemia that often accompanied with metabolic syndrome (MetS) in the first diagnosis. MetS is a cluster of conditions that can increase the risk of cardiovascular diseases, heart disease and stroke, which may increase all-cause mortality. Due to the complexity of MetS diagnosis, MetS is often overlooked in clinical practice. In

present study, we found a convenient and reliable risk predictor of PrFT for MetS in patients with Newly-Diagnosed T2DM. The results in our study showed that the prevalence of patients with MetS was 58.2% in Longyan, China. PrFT Showed a close correlation with metabolic risk factors both in men and women. Moreover, PrFT was significantly associated with higher odds of MetS in both men and women after adjustment for other confounders. The optimal cut-off values of PrFT predicting MetS in Newly-Diagnosed T2DM was 14.6 mm in men and 13.1 mm in women.

The prevalence of MetS in our study is relatively lower than a recent study involving 15,492 newly diagnosed with diabetes in 46 tertiary care hospitals(7 south) across China that reported the prevalence of MetS is 68.1% using 2017 CDS definition^[2]. To date, there is no study has reported the prevalence of MetS in southern Chinese Newly-Diagnosed T2DM. Moreover, the prevalence of MetS may vary in geographic distribution, a recent survey reported the prevalence of MetS was higher in northern China residents than in southern China residents^[15]. We assumed the lower prevalence of MetS in our study may due to the majority of our patients are from southern China. Visceral fat and subcutaneous fat are the most important and common categories in adipose biology based on the anatomical and physiological characteristics of fat depots. Compared with subcutaneous fat, visceral fat play more functional roles in pathogenesis of CVD, metabolic disorders and T2DM based on Biological characteristics, which can release bioactive factors such as leptin, adiponectin, leptin, tumor necrosis factor- α (TNF- α), interleukin-6 (IL-6), interleukin-8 (IL-8) and MCP-1^[16, 17]. Clinical evidences demonstrated that Asian are more likely to have more obesity related consequences in patients with lower WC and BMI due to more visceral fat mass deposition compared with Caucasians^[18]. CT scanning is a reliable tool to quantify adipose tissue depots. The density of adipose tissue in Hounsfield Unit (HU) can be used to distinguish perirenal fat from other tissues, which has been validated by direct measurement of fat tissue in humans. Among visceral adipose tissue deposits, perirenal fat mass is also associated with metabolic disorders, and perirenal fat thickness (PrFT) measured by CT scanning had showed a positive correlation with perirenal fat mass^[7]. Thus, in our study we used CT scanning to measure the PrFT in the maximal distance between the posterior wall of the kidney and the inner limit of the abdominal wall across the renal venous plane.

Perirenal fat is a kind of fat mass located in the retroperitoneal space and surrounded the kidneys that can be quantitative measured by radiological diagnosis for renal positioning. The anatomical structure and location of perirenal fat determined its specific biological characteristics. Compared with other adipose tissues classified as loose connective tissues, perirenal fat has a complete system of blood supply, lymph fluid drainage, innervation and other special morphological features, include intact fascial boundaries, structural development independent of the sympathetic nerve, and proximity to the kidney ,Which makes it similar to other internal organs and different from traditional classified connective tissues^[8]. These special anatomical structure ensured perirenal fat can modulate the metabolism system through neural reflexes^[19], adipokine secretion^[20], adipocytes interactions^[21] and paracrine substance(TNF- α)^[22]. Among them, adipokines(leptin, adiponectin, apelin and nesfatin) play important regulatory roles in endocrine metabolic systems, insulin sensitivity, and lipolysis via the autocrine,

paracrine, and endocrine pathways^[23, 24]. Thus, these specific biological and anatomical characteristics of PrFT provided a basis for the involvement of perirenal fat in MetS regulation.

Clinical studies have also observed the association between PrFT and metabolic risk factors. A study enrolled overweight and obese subjects showed that PrFT was independently associated with HDL-c and WC^[12]. The another study has also showed PrFT was significantly correlated with metabolic risk factors such as UA, TG and WC in patients with chronic kidney disease^[25]. Moreover, PrFT also showed a positive independent association between PrFT and mean 24-h diastolic blood pressure levels in overweight and obese subjects^[26]. The results in our study also showed a positive correlation between PrFT and HOMA-IR, which was confirmed to participate in the occurrence and development of MetS and T2DM^[27]. Meanwhile, PrFT is also reported to be associated with other metabolic diseases and T2DM complications. Satsuki K et al have also demonstrated that PrFT can be a reliable method for the quantification of fatty liver as well as for the quantification of visceral fat^[28]. Increasing evidences have suggested that the accumulation of perirenal fat increase the risk for development of chronic kidney disease through decreasing the eGFR level and increasing the excretion rate of urinary protein^[29–31]. The results in our study were consistent with these previous studies, PrFT was correlated with metabolic risk factors like WC, TG, HDL-c, SBP, DBP, UA and HOMA-IR. As expected, PrFT was significantly independent with higher odds(95%CI) of MetS in men and women after adjustment for other confounders. The process of MetS diagnosis is complicated (including lipid testing, waist circumference, continuous glucose monitoring and blood pressure measurement) that cause the delay diagnosis of MetS. ROC curve analysis results in our study showed a good predictive value of PrFT for MetS both in men and women, which indicated PrFT could be a convenient and reliable predictor for MetS in patients with Newly-Diagnosed T2DM.

To our knowledge, this is the first study confirmed the predicting value of PrFT for MetS in patients with Newly-Diagnosed T2DM. Due to the majority of our patients are from southern China, the optimal cut-off values of PrFT may be not applicable to patients in northern China. In conclusion, in this cross-sectional study, a novel predictor for MetS in patients with Newly-Diagnosed T2DM was found, PrFT was significantly independent with MetS and showed a powerful predictive value for MetS, which suggested PrFT could be a potential indicator to help clinicians to screen high-risk groups in patient with Newly-Diagnosed T2DM.

Declarations

Competing Interests

We declared that all authors have read and approved the manuscript and there is no conflict of interest existing in the submission of this manuscript, and manuscript is approved by all authors for publication.

Author contributions

Data curation: Wei Wang.

Investigation: Wei Wang, Xiuli Guo, Yang Chen, Mei Tu.

Software: Xiuli Guo.

Writing – original draft: Xiuli Guo.

Writing – review & editing: Wei Wang.

Ethics approval

All procedures were conducted in accordance with Declaration of Helsinki, and this study was approved by the Ethical Committee of Longyan First Affiliated Hospital of Fujian Medical University (LY-2020–069) and registered in Clinical Trials. Gov (ChiCTR2100052032).

Consent to participate

Informed consent was obtained from all individual participants included in the study.

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Figures

Figure 1

The average of maximal thickness values (blue line) between the posterior wall of the kidney and the inner limit of abdominal wall across the renal venous plane were defined as the PrFT.

Figure 2

Flow diagram of patients excluded and included in this study.

Figure 3

ROC curves for cut-off value of PrFT to predict MetS. In men: area under the Curve were 0.895(95% CI 0.852~0.939) in men and 0.910(95% CI 0.876~0.953) in women($P < 0.001$). Optimal cut-off values of PrFT were 14.6 mm (sensitivity: 83.8%, specificity: 89.6%) for men and 13.1 mm (sensitivity: 87.6%, specificity: 91.1%) for women.