Perirenal Fat and Association With Metabolic Risk Factors

The Uberlândia Heart Study

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Abstract: Perirenal fat (PRF) is associated with cardiovascular risk factors. Gender differences in the correlations of cardiovascular disease risk factors and PRF in the Brazilian population are lacking. Cross-sectional study with 101 (50.49% men; mean age 56.5 ± 18, range 19–74 years) drawn from the Uberlândia Heart Study underwent ultrasonography assessment of abdominal adipose. For the PRF, a 3.5 MHz transducer was measured in the middle third of the right kidney, with the transducer positioned at the axillary midline. The examinations were always performed by the same examiner. The PRF thickness was examined in relation to waist circumference, blood pressure, and metabolic risk factors. The PRF was significantly associated with the levels of gamma-glutamyl transferase (P < 0.05, r = 0.08), fasting plasma glucose (P < 0.05, r = 0.07), waist circumference (P < 0.05, r = 0.10), and metabolic syndrome (P < 0.001, r = 0.38) in men, and with the levels of fasting plasma glucose (P < 0.05) in women. The PRF was correlated with most cardiovascular risk factors in men and only in glucose at the women.

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INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of morbidity and mortality in the world. Visceral fat is a risk factor for multiple CVD risk factors, including hypertension, dyslipidemia, diabetes, and the metabolic syndrome (MetS).1–5

In a systematic analysis of epidemiological studies carried out in 199 countries, it was revealed that about 1.46 billion adults were overweight, and of these 502 million were obese.6

Abdominal obesity is closely associated with hypertension, insulin resistance, type 2 diabetes, dyslipidemia, abnormal secretion of adipokines, and CVD. Obesity is the central role of the MetS, which further includes renovascular risk factors such as endothelial dysfunction, albuminuria, dyslipidemia, hypertension, and glucose disturbances.7–12

The accumulated perirenal fat (PRF) on the kidneys and firmly encapsulating them can damage kidney function.13,14

The aim of this study was to analyze the association among PRF and other obesity-related parameters, such as waist circumference (WC), blood pressure and metabolic risk factors.

METHODS

Study Sample

Cross-sectional study with 101 volunteers (50.49% men; mean age 56.5 ± 18, range 19–74 years) drawn from the Uberlândia Heart Study underwent ultrasonography assessment of abdominal adipose tissue. The study was approved by the institutional review boards of the Federal University of Uberlândia. All subjects provided written informed consent.

Abdominal Adipose Tissue Measurements

A Versa Pro (Siemens; Erlangen, Germany) ultrasound equipment with transducer of 3.5 MHz was used to measure the PRF thickness. The patient was positioned in dorsal decubitus, and the transducer was positioned at the axillary midline in the longitudinal plain (Fig. 1). Then the image of the right kidney and perirenal area was observed, with posterior measurement of the lateral hypoechoic area that matches to the PRF in millimeters. The examinations were always performed by the same examiner.

Due to method validation in a previous study, we chose the right PRF. Patients with difficulties in obtaining images (meteorism, renal parenchymal anomalies) were excluded.

Risk Factor and Covariate Assessment

Risk factors and covariates were measured at the examination. Body mass index, defined as weight (in kilograms) divided by the square of height (in meters), was measured at each index examination. WC was measured at the level of the umbilicus. Fasting plasma glucose and lipid profile were measured on fasting morning samples. Diabetes was defined as a fasting plasma glucose level ≥126 mg/dL. Impaired fasting glucose was defined as a fasting plasma glucose level of 100 to 125 mg/dL among those not treated for diabetes. Hypertension was defined as systolic blood pressure 135 mm Hg, diastolic blood pressure 85 mm Hg, or on treatment. MetS was defined from modified Adult Treatment Panel criteria.

Statistical Analysis

PRF was normally distributed. Sex-specific age-adjusted Pearson correlation coefficients were used to assess simple correlations between PRF and metabolic risk factors.
Multivariable linear and logistic regression was used to assess the significance of covariate-adjusted cross-sectional relations between continuous and dichotomous metabolic risk factors and PRF. A *P* value of 0.05 was considered to indicate significance. SPSS Version 21 software (SPSS, Chicago, IL) was used.

**RESULTS**

**Baseline Characteristics**

Overall, 49 women and 52 men were available for analysis. The mean age of the study sample was 48 for women and 52 for men, and 48.5% were women (Tables 1–3); 40.2% were hypertensive, 61.8% abdominal obesity, 32% hypertriglyceridemia, 33.2% low high-density lipoprotein cholesterol and high low-density lipoprotein cholesterol, 40.2% high total cholesterol, 33.2% high non–high-density lipoprotein cholesterol, 22.7% mixed dyslipidemia, 20.2% impaired fasting glucose, and 41.1% had MetS (Figures 2–4). Mean PRF fat thickness was 0.2 cm in both women and men.

**DISCUSSION**

In the present study, we found the association of PRF with the levels of gamma-glutamyl transferase (GT), fasting plasma,

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**TABLE 1. Study Sample Characteristics**

|                          | Men (52)            | Women (49)           |
|--------------------------|---------------------|----------------------|
| Age                      | 52 (13)             | 48 (6.4)             |
| BMI, kg/m²               | 25.9 (4.1)          | 26.3 (3.4)           |
| Overweight (BMI ≥25 and ≥30), % | 26.9               | 26.5                 |
| Obesity grade 1(BMI ≥30and ≥35), % | 7.6               | 18.3                 |
| WC, cm                   | 96.2(11.9)          | 85.2(10.9)           |
| WC ≥94 cm man and 80 cm woman, % | 55.7               | 69.3                 |
| Triglycerides, mg/dL     | 167.6(39–638)       | 123.8(44–490)        |
| Hypertriglyceridemia ≥150 mg/dL, % | 40.3               | 24.4                 |
| HDL cholesterol, mg/dL   | 45.7(11.7)          | 52.2(11.2)           |
| LDL cholesterol, mg/dL   | 34.6                | 32.6                 |
| LDL cholesterol, mg/dL, ≥130, % | 34.6               | 32.6                 |
| Total cholesterol, mg/dL | 191.3(38.4)         | 196.2(40.3)          |
| Total cholesterol mg/dL ≥200, % | 36.5               | 44.8                 |
| Non-HDL, mg/dL           | 148.6(35.7)         | 141.9(42)            |
| Non-HDL ≥160 men and 150 women, mg/dL, % | 32.6               | 34.6                 |
| Mixed dyslipidemia, %    | 13.4                | 32.6                 |
| AST, U/L                 | 17.2(7.8)           | 12.9(2.9)            |
| ALT, U/L                 | 40.3(23.3)          | 25.2(11)             |
| GGT                      | 43.7(34.4)          | 25.2(17.1)           |
| Systolic blood pressure, mm Hg | 126.4(15.4)        | 121.3(16.8)          |
| Diastolic blood pressure, mm Hg | 84.8(9.5)         | 81.5(9.7)            |
| Hypertension, %          | 48.7                | 32.6                 |
| Fasting plasma glucose, mg/dL | 96.3(10.8)        | 90.8(10.8)           |
| Impaired fasting glucose, % | 28.8               | 12.2                 |
| MetS, %                  | 38.4                | 44.8                 |
| Postmenopausal, %        | 36.7                | ...                  |
| Hormone replacement therapy, % | 34.6               | ...                  |
| PRF, cm                  | 0.2(0.8)            | 0.27(1)              |

ALT = alanine aminotransferase, AST = aspartate transaminase, BMI = body mass index, GGT = gamma-glutamyl transferase, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, MetS = metabolic syndrome, PRF = perirenal fat, WC = waist circumference.
The visceral fat accumulation is a major determinant of increased risks for cardiovascular and metabolic diseases. The perirenal ultrasonographic fat thickness measurement may better reflect the risks commonly associated with increased visceral fat accumulation and particularly those related to renal function impairment, microalbuminuria, hypertension, and uricemia. The perirenal adipose tissue has been shown to compress renal vessels and renal parenchyma, causing elevated renal interstitial hydrostatic fluid, and reductions in both renal blood and tubular flow rate.

Among the mechanisms proposed to explain the association between visceral obesity with hypertension, we found an increase in sodium reabsorption and sympathetic activity in obese patients. In others studies, the renal sinus fat accumulations displaces and compresses the renal veins and lymphatic vessels, as well as compress the ureters causing an increase in hydrostatic pressure and renal activation of the renin–angiotensin–aldosterone system causing hypertension resistant insulin, atherosclerosis.

The thickness of the PRF may indicate individuals who have an increased atherosclerotic disease development potential.

| TABLE 2. Sex-Adjusted Pearson Correlation Coefficients between Metabolic Risk Factors and PRF Thickness |
|-----------------|-----------------|-----------------|-----------------|
|                 | Men             | MetS            | Women           |
| BMI, kg/m²      | −0.28           | −0.13           | −0.09           | −0.13 |
| WC, cm          | 0.05            | 0.23            | −0.02           | −0.013 |
| Triglycerides, mg/dL | −0.17           | −0.37           | −0.32           | 0.02  |
| HDL cholesterol, mg/dL | 0.4             | 0.25            | 0              | −0.28 |
| LDL cholesterol, mg/dL | 0.22            | 0.41            | −0.19           | −0.04 |
| Total cholesterol, mg/dL | 0.05            | 0.24            | −0.32           | 0.02  |
| Non-HDL, mg/dL  | 0.6             | 0.20            | −0.32           | 0.7   |
| AST, U/L        | −0.12           | 0.13            | −0.18           | −0.09 |
| ALT, U/L        | −0.24           | 0.17            | −0.08           | −0.24 |
| GGT             | −0.18           | 0.47            | −0.19           | −0.45 |
| Systolic blood pressure, mm Hg | −0.18          | 0.23            | −0.14           | 0.34  |
| Diastolic blood pressure, mm Hg | −0.12          | 0.18            | 0.28            | 0.14  |
| Fasting plasma glucose, mg/dL | −0.12          | 0.27            | −0.6            | −0.47 |
| MetS            | 0.38            | *               | *               | *    |

ALT = alanine aminotransferase, AST = aspartate transaminase, BMI = body mass index, GGT = gamma-glutamyl transferase, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, MetS = metabolic syndrome, PRF = perirenal fat, WC = waist circumference.

| TABLE 3. Sex-Specific Multivariable-Adjusted* Regressions for PRF With Continuous Metabolic Risk Factors (Top) and Dichotomous Risk Factors |
|-----------------|-----------------|-----------------|
|                 | Men             | MetS            | Women           |
| BMI, kg/m²      | −0.15           | −0.50           | 0.44            | −0.16 |
| WC, cm          | 0.10            | 0.05            | 0              | 0.01  |
| Triglycerides, mg/dL | 0              | 0.14            | 0.01            | 0.04  |
| HDL cholesterol, mg/dL | 0.01           | 0.06            | 0.02            | 0.08  |
| LDL cholesterol, mg/dL | 0.02           | 0.17            | 0              | 0     |
| Total cholesterol, mg/dL | 0.01           | 0.05            | 0.03            | 0     |
| Non-HDL, mg/dL  | 0.38            | 0.78            | −0.17           | 0.12  |
| AST, U/L        | 0.38            | 0.01            | 0.01            | 0     |
| ALT, U/L        | 0.02            | 0.03            | 0.01            | 0.06  |
| GGT             | 0.08            | 0.22            | 0.03            | 0.21  |
| Systolic blood pressure, mm Hg | 0.06          | 0.03            | 0              | 0.11  |
| Diastolic blood pressure, mm Hg | 0.03          | 0.05            | 0              | 0.02  |
| Fasting plasma glucose, mg/dL | 0.07          | 0.07            | 0.08            | 0.22  |
| MetS            | 0.14            | *               | *               | *    |

ALT = alanine aminotransferase, AST = aspartate transaminase, BMI = body mass index, GGT = gamma-glutamyl transferase, HDL-C = high density lipoprotein cholesterol, LDL-C = low density lipoprotein cholesterol, MetS = metabolic syndrome, PRF = perirenal fat, WC = waist circumference.

*P < 0.05.
FIGURE 4. Risk factors in men.

STRENGTHS AND LIMITATIONS
This is not a multicenter study.
Novelty and Significance.
What is new is that the thickness of abdominal fat was correlated with cardiovascular risk factors in humans. Among the main factors in the correlation was positive in men with WC, gamma-GT, fasting plasma glucose, and MetS in men, and with the levels of fasting plasma glucose in women. The PRF is associated with cardiovascular risk factors.

CONCLUSION
The PRF is associated with an adverse metabolic risk profile.

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