Abdominal fat index by ultrasound does not estimate the metabolic risk factors of cardiovascular disease better than waist circumference in severe obesity

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SUMMARY

Objective: To evaluate by ultrasound the ratio between preperitoneal (P) and subcutaneous (S) fat (AFI), in quantifying the cardiovascular risk in 258 obese patients (BMI 41.2∂6.3 kg/m^2; age 45.1 ∂ 13.6 years).

Research methods and procedures: Glucose, insulin, lipid profile, uric acid and fibrinogen were measured. HOMA-IR, waist girth, AFI and quartiles of BMI were calculated.

Results: AFI lowered with increasing BMI and showed a positive correlation with TGL ($r = 0.37$, $P < 0.01$) and uric acid ($r = 0.40$, $P < 0.001$) in the 1st quartile of BMI (30.2-36.4) and a negative correlation with HDL ($r = -0.32$, $P < 0.001$) in the 3rd quartile (40.6-45.1). When BMI exceeded the value of 45.2 kg/m^2 these correlations were no longer significant. In all subjects S correlated positively with uric acid ($r = 0.64$, $P < 0.001$), and negatively with HOMA-IR ($r = -0.41$, $P < 0.001$) and TGL ($r = -0.35$, $P = 0.02$); P correlated positively with CHOL ($r = 0.48$, $P = 0.04$) and TGL ($r = 0.33$, $P = 0.03$), and negatively with HDL ($r = -0.46$, $P = 0.03$). Waist girth showed more significant correlations than AFI in the lower quartiles of BMI, but not at the highest one.

Discussion: AFI, P and S, as waist girth do not seem to quantify the metabolic risk factors of cardiovascular disease in severe obese subjects, but AFI is probably useful in obese populations with BMI < 45 kg/m^2, even though not as strong as waist girth.

Key-words: Ultrasonography · Fat distribution · Preperitoneal fat thickness · Cardiovascular risk.

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RÉSUMÉ

La valeur de l'indice de la graisse abdominale déterminé par ultrasonographie n'est pas supérieure au tour de taille pour estimer les facteurs de risque métaboliques de maladie cardiovasculaire dans l'obésité sévère

Objectifs : Évaluer les liens éventuels entre le rapport entre l'épaisseur du tissu adipeux abdominal prépéritonéal (P) et celle du tissu adipeux sous-cutané (S) mesurés par ultrasonographie (indice AFI) et le risque cardiovasculaire chez 258 patients atteints d'obésité sévère (IMC 41,2 ∂ 6,3 kg/m^2, âge 45,1 ∂ 13,6 ans).

Matériels et méthodes : Nous avons mesuré le tour de taille des patients et la glycémie, l'insulinémie, les paramètres lipidiques, le fibrinogène et l'uricémie. L'indice de masse corporelle (IMC) et ses quartiles, l'indice AFI et le HOMA-IR (pour la sensibilité périphérique à l'insuline) ont été calculés.

Résultats : L'indice AFI était d'autant plus bas que l'IMC était élevé. Il existait une corrélation significative entre l'indice AFI et les concentrations de triglycérides ($r = 0.37$, $P < 0.01$) et l'uricémie ($r = 0.40$, $P < 0.001$) dans le 1er quartile de IMC (30.2-36.4) et une corrélation négative avec le cholestérol-HDL ($r = -0.32$, $P < 0.001$) dans le 3e quartile (40.6-45.1). La corrélation disparaissait quand l'IMC était supérieur à 45 kg/m^2. Chez tous les patients, l'épaisseur du tissu adipeux sous-cutané était en corrélation positive avec l'uricémie ($r = 0.64$, $P < 0.001$), et en corrélation négative avec le HOMA -IR ($r = -0.41$, $P < 0.001$) et les triglycérides ($r = -0.35$, $P = 0.02$) ; l'épaisseur du tissu adipeux abdominal était en corrélation positive avec le cholestérol total ($r = 0.48$, $P = 0.04$) et les triglycérides ($r = 0.33$, $P = 0.03$), et en corrélation négative avec le cholestérol-HDL ($r = -0.46$, $P = 0.03$). Il existe une corrélation plus étroite entre le tour de taille et les paramètres évalués qu'entre l'indice AFI et ces paramètres dans les quartiles les plus bas de l'IMC, et non dans les quartiles élevés.

Conclusions : L'indice AFI, l'épaisseur du tissu adipeux abdominal et sous-cutané et le tour de taille ne semblent pas quantifier le risque métabolique de maladie cardiovasculaire dans l'obésité morbide. L'indice AFI a un intérêt dans l'obésité avec un IMC < 45 kg/m^2, mais avec une signification inférieure à celle du tour de taille.

Mots-clés : Échographie · Répartition du tissu adipeux · Tissu adipeux abdominal prépéritonéal · Risque cardiovasculaire.

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Introduction

Obesity is often associated with an increase of cardiovascular risk factors, which include glucose intolerance or overt diabetes mellitus, hypertension and dyslipidemia [1]. The onset of these abnormalities has been shown to be related to the indices of body fat distribution, i.e. waist to hip ratio (WHR) or waist girth, as well as to the amount of body fat [2-5]. Therefore, it may be crucial to discriminate the clinical usefulness of methodologies measuring fat compartments in obesity.

Computed tomography (CT) and Magnetic Resonance Imaging (MRI) enable careful measurement of the proportion of subcutaneous to visceral fat [6, 7]. Major caveats of these techniques are exposure to X-ray and cost, respectively; in addition, CT scans and even moreso MRI cannot be performed in severely obese patients due to excessive patients' weight and or abdominal circumference. On the contrary, the estimation of adipose tissue by ultrasound is considered as an accurate and low cost approach available in many institutions worldwide [8-11].

Ultrasound measurements have been recently shown to correlate better with cardiovascular risk factors than those derived from anthropometric measures, but these findings, although relevant, are obtained from moderately obese series of patients [12, 13].

Suzuki et al. introduced the Abdominal wall Fat Index (AFI), to indicate the ratio between the thickness of preperitoneal (P) and subcutaneous fat (S) evaluated by ultrasound, and observed its significant positive correlation with cardiovascular risk factors [14, 15]. This method allows to easily evaluate a fat compartment, i.e. P, claimed to reflect the amount of visceral fat [14]. Moreover, the subcutaneous fat depot was related to liver steatosis and insulin resistance and insulin receptors were found in this fat compartment [10]. Thus it is felt that the method of Suzuki could significantly improve the reliability of measurements, particularly in severe obesity, considering that abdominal compression, usually requested with the other procedures, is avoided [16, 17]. Based on this evidence, the aim of our study was to measure AFI in a large sample of obese patients and to compare it with waist circumference in order to assess the relationship between these indexes and cardiovascular risk factors at different ranges of obesity.

Research methods and procedures

Subjects

Two hundred and fifty-eight obese Caucasian patients, 103 males and 155 females, BMI 41.2 ∂ 6.3 kg/m^2 (mean ∂ SD), aged 45.1 ∂ 13.6 years, were enrolled in the study. Patients with kidney, liver or heart failure were excluded, as well as patients treated with insulin, lipid lowering drugs or thiazolidinediones. Diabetic subjects had good glycaemic control, as reflected by values of glycated hemoglobin < 7%; hypertensive subjects where well controlled by pharmacological treatment as reflected by values of systolic and diastolic blood pressure below 135 and 85 mmHg in three repeated measurements.

Biochemistry

Fasting plasma glucose, insulin, cholesterol (CHOL), HDL-cholesterol, triglycerides (TGL), uric acid and fibrinogen measured on a blood sample taken at 08.00 h, after overnight fast were measured. Glucose, CHOL, HDL-cholesterol, LDL-cholesterol, TGL, fibrinogen and uric acid were measured by an enzymatic method; insulin was determined by immunoenzymatic methods (Tosoh, Kyobashi Chuo-Ku, Tokio, Japan). Insulin resistance was expressed by homeostasis model assessment (HOMA-IR) (18); twenty-two patients under treatment with biguanides were excluded from this calculation.

Body composition

The waist girth was taken to the largest standing horizontal circumference between the ribs and the iliac crest.

The thickness of the preperitoneal fat layer (P) and subcutaneous fat layer (S) in the abdomen were measured using a real-time ultrasound scanner equipped with a linear 7.5 MHz LA13A transducer (ESAOTE-AU4 BIOMEDICA Spa, Genova, Italy). As previously reported [8], all measurements were carried out by a single skilled operator (A.M.), with the subjects laying in a supine position. The linear-array probe was kept perpendicularly to the skin on the upper median abdomen and longitudinal scanning was done under the xiphoid process. Each measurement was performed without compression of the abdominal wall with the transducer. The thickness of subcutaneous fat (S), i.e. the maximum distance from the subcutaneous tissue to the linea alba, and that of preperitoneal fat (P), i.e. the maximum distance from linea alba to the surface of the left lobe of the liver, were measured directly from the screen with electronic caliber, and AFI was calculated as P to S ratio.

Validation

In a subgroup of 21 patients having age, sex and BMI comparable to the whole group, the measurements of S and P were repeated five times and the obtained coefficients of variation were 3% (range 1.24-6.58%) and 4.2% (range 0.86-7.75%), respectively. Furthermore, in a subgroup of 15 obese subjects the ultrasound measurements were compared with those derived from a single slice obtained by CT located through the L4-L5 interspace, by measuring the surfaces of subcutaneous (S) and visceral (V) fat, and by calculating V to S ratio. A further CT slice was performed at subxiphoid level for comparing the thickness of the subcutaneous and preperitoneal fat evaluated by the two