Usefulness of Hypertriglyceridemic Waist Phenotype in Type 2 Diabetes Mellitus to Predict the Presence of Coronary Artery Disease as Assessed by Computed Tomographic Coronary Angiography

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The present study tested whether in patients with type 2 diabetes mellitus (DM) the combination of increased waist circumference and increased plasma triglyceride (TG) levels can predict the presence of coronary artery disease (CAD) as assessed by multidetector computed tomographic coronary angiography (CTA). In 202 patients with type 2 DM who were clinically referred for CTA, waist circumference and TG levels were measured. Patients were divided into 4 groups according to waist circumference measurements and TG levels. Increased waist circumference and TG levels (n = 61, 31%) indicated the presence of the hypertriglyceridemic waist phenotype. Patients with low waist circumference and TG (n = 49, 24%) were considered the reference group. Physical examination and blood measurements were performed. CTA was used to determine presence and severity of CAD. In addition, plaque type was evaluated. Plasma cholesterol levels were significantly increased in the group with increased TG levels and waist circumference, whereas high-density lipoprotein cholesterol was significantly lower than in the reference group. There was a significant increase in the presence of any CAD (odds ratio 3.3, confidence interval 1.31 to 8.13, p <0.05) and obstructive CAD (≥50%, odds ratio 2.9, confidence interval 1.16 to 7.28, p <0.05) in the group with increased TG level and waist circumference. In addition, a significantly larger number of noncalcified and mixed plaques was observed. In conclusion, in patients with type 2 DM, presence of the hypertriglyceridemic waist phenotype translated into a deteriorated blood lipid profile and more extensive CAD on CTA. Accordingly, the hypertriglyceridemic waist phenotype may serve as a practical clinical biomarker to improve risk stratification in patients with type 2 DM. **© 2010 Elsevier Inc. All rights reserved. (Am J Cardiol 2010;106:1747–1753)**

The aim of the present study was to test whether the hypertriglyceridemic waist phenotype in patients with type 2 diabetes mellitus (DM) can predict the presence of coronary artery disease (CAD) as assessed by multidetector computed tomographic coronary angiography (CTA). A second aim was to assess differences in atherosclerotic plaque characteristics in diabetic patients with and without the presence of hypertriglyceridemic waist phenotype using CTA.

Methods

All patients were asymptomatic and were referred from a routine outpatient diabetes clinic for cardiovascular risk stratification. Patients were diagnosed as having type 2 DM according to American Diabetes Association

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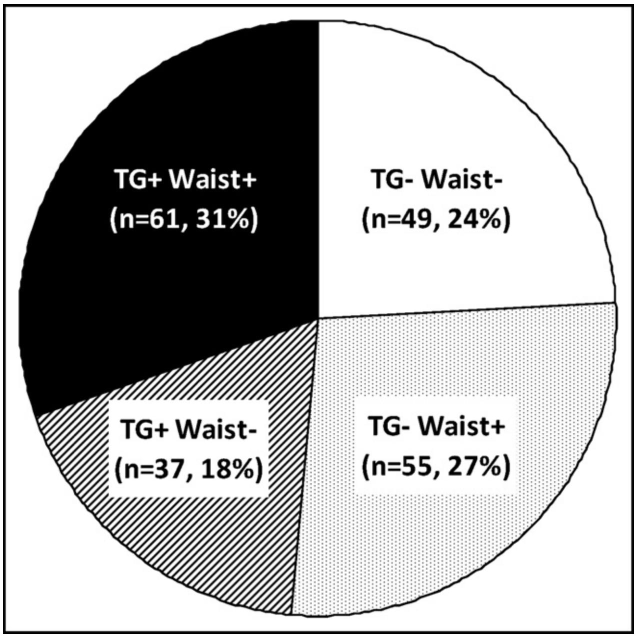

Figure 1. Distribution of patient with type 2 diabetes mellitus over 4 groups according to waist circumference and triglyceride levels. Proportions of patients with type 2 diabetes mellitus and the hypertriglyceridemic waist phenotype *(black area)* and patients with type 2 diabetes mellitus and without the hypertriglyceridemic waist phenotype (reference group) *(white area)* are displayed.

Table 1
Baseline patient characteristics

	$\text{TG}^{-}\text{waist}^{-}$ (n = 49)	$\text{TG}^{+}\text{waist}^{+}$ (n = 61)
Men/women	37/12[§]	26/34[§]
Age (years)	54 ± 10	55 ± 10
Known coronary artery disease	0	3 (4.9%)
Previous myocardial infarction	0	2 (3.3%)
Previous coronary artery bypass grafting	0	1 (1.6%)
Previous percutaneous coronary intervention	0	1 (1.6%)
Family history of coronary artery disease*	21 (43%)	25 (41%)
Hypertension[†]	17 (34.7%)[§]	44 (72.1%)[§]
Obesity (body mass index ≥30 kg/m^2)	3 (6.1%)[§]	37 (60.7%)[§]
Smoking	10 (20%)	31 (21%)
Medication[‡]		
β Blockers	3 (7%)	4 (7%)
Diuretics	4 (9%)[§]	14 (25%)[§]
Statins	21 (49%)	25 (46%)
Calcium-antagonists	3 (7%)	10 (19%)

Data are mean ± SD or number of patients (percentage).

* Defined as presence of coronary artery disease in first-degree family members at <55 years of age in men and <65 years of age in women.

[†] Defined as systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg and/or use of antihypertensive medication.

[‡] In 13 patients medication information was not available.

[§] $p < 0.05$.

criteria.[1] As a result, 202 diabetic patients (120 men and 82 women, mean age 54 ± 11 years) were enrolled in the study population. Exclusion criteria for CTA were (1) (supra)ventricular arrhythmias, (2) renal insufficiency (glomerular filtration rate <30 ml/min), (3) known allergy to iodine contrast material, (4) severe claustrophobia, and (5) pregnancy. At physical examination, waist circumference and blood pressure measurements were performed. In addition, blood samples were obtained in the morning after a 12-hour fast. Triglyceride (TG), low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, apolipoprotein B, and C-reactive protein levels were measured.

Patients were divided into 4 groups using threshold values for waist circumference measurements (≤88 or >88 cm for women and ≤102 or >102 cm for men) and TG levels (<1.7 or ≥1.7 mmol/L for men and women) as previously described by National Cholesterol Education Program Adult Treatment Panel III.[2] Figure 1 illustrates patient distribution over the 4 groups. Type 2 diabetic patients with a large waist circumference and increased TG levels, signifying the presence of the hypertriglyceridemic waist phenotype, were denoted $\text{TG}^{+}\text{waist}^{+}$. Diabetic patients with a small waist circumference and low TG levels were considered the reference group, denoted $\text{TG}^{-}\text{waist}^{-}$, to which a CAD odds ratio of 1.0 was designated for comparison purposes.

CT coronary angiographic studies, including calcium scores, were performed using 2 different systems: 64-row CTA (Aquilion 64, Toshiba Medical Systems, Otawara, Japan) and 320-row CTA (Aquilion ONE, Toshiba Medical Systems) with 64 and 320 simultaneous detector rows, respectively (each 0.5-mm wide). Unless contraindicated, oral β-blocker medication (metoprolol 50 or 100 mg) was administered to patients with a heart rate ≥65 beats/min 1 hour before the investigation.[3] The total amount of nonionic contrast medium (Iomeron 400; Bracco, Milan, Italy) injected into the antecubital vein was 60 to 100 ml (depending on body weight and scanner type) at a flow rate of 5.0 or 6.0 ml/s, followed by a saline flush of 25 to 50 ml. To synchronize the arrival of contrast medium, bolus arrival was detected using a real-time bolus-tracking technique.[4] All images were acquired during a single inspiratory breath-hold of maximally 12 seconds. For 64-row CTA, a helical-scanning technique was used,[5,6] and for 320-row CTA, a volumetric scanning technique was used.[7] Average investigation time for CT acquisition was approximately 20 minutes.

To examine the relation between hypertriglyceridemic waist and CAD in patients with type 2 DM, all CT coronary angiographic scans were evaluated for presence of CAD. CT coronary angiographic reconstructions were transferred to a remote workstation with dedicated analysis software (for 64-row CT coronary angiographic reconstructions: Vitrea 2, Vital Images, Minnetonka, Minnesota; for 320-row CT coronary angiographic reconstructions: Vitrea FX 2.0, Vital Images). Coronary arteries were evaluated using the reconstruction dataset with the fewest motion artifacts, typically acquired during a mid-diastolic phase. When multiple reconstructions from different cardiac phases were available, reconstruction with the best image quality was evaluated. CT coronary angiographic scans were evaluated by 2 experienced observers. Discrepancies in the interpretation of CT coronary angiographic examinations were immedi-

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