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Clinical Science

Metabolically obese status with normal weight is associated with both the prevalence and severity of angiographic coronary artery disease

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ARTICLE INFO

Article history:

Received 8 September 2012

Accepted 7 January 2013

Keywords:

Obesity

Metabolically obese but normal weight

Coronary artery disease

ABSTRACT

Objective. We evaluated prevalence and severity of angiographic coronary artery disease (CAD) according to groups by metabolically obese (MO) and/or weight status.

Material/methods. Normal weight was defined as body mass index (BMI, kg/m²) < 25 and obesity was defined as BMI ≥ 25. The MO was determined using the National Cholesterol Education Program-Adult Treatment Panel III classification with Korean-specific cutoffs for abdominal obesity. Therefore, a total of 856 subjects were categorized as follows: (1) metabolically healthy and normal weight (MHNW); (2) metabolically obese but normal weight (MONW); (3) metabolically healthy but obese (MHO); and (4) metabolically abnormally obese (MAO). The presence of obstructive lesion ≥ 50% of coronary artery was considered as an angiographic CAD and the Gensini scoring system was used for the severity.

Results. MONW or MO showed a higher prevalence of CAD than MHNW or non-MO after adjustment for age and sex, respectively (MONW, odds ratio [OR] = 1.69, 95% confidence interval [CI]: 1.13–2.51 and MO, OR = 1.44, 95% CI: 1.09–1.91). In subjects without diabetes mellitus (DM), MONW or MO showed a marginally higher prevalence of CAD (MONW, OR = 1.58, 95% CI: 0.96–2.61 and MO, OR = 1.41, 95% CI: 0.96–2.08). MONW was independently associated with a higher severity of angiographic CAD than MHNW after age, sex, glomerular filtration rate, smoking status, high sensitive C-reactive protein, and use of anti-platelet and anti-angina drugs ($\beta = 0.118$, $P = 0.005$). And MO was associated with a higher severity of angiographic CAD than non-MO after adjustment for age and sex ($\beta = 0.077$, $P = 0.024$). The above associations were also consistent in subjects without DM (MONW, $\beta = 0.147$, $P = 0.003$ and MO, $\beta = 0.129$, $P = 0.005$).

Abbreviations: DM, type 2 diabetes mellitus; CAD, coronary artery disease; MHO, metabolically healthy but obese; MO, metabolically obese; MONW, metabolically obese but normal weight; BMI, body mass index; MHNW, metabolically healthy and normal weight; MAO, metabolically abnormally obese; WC, Waist circumference; HC, Hip circumference; GFR, Estimated glomerular filtration rate; LMA, left main coronary artery; LAD, left anterior descending artery; LCX, left circumflex artery; OM, obtuse marginal branch; RCA, right coronary artery; PDA, posterior descending artery; SD, standard deviation; ANOVA, analysis of variance; OR, odds ratio; CI, confidence interval; MetS, metabolic syndrome.

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Conclusions. MONW or MO is associated with both the prevalence and severity of angiographic CAD after adjustment for age and sex and MONW is independently associated with the severity of angiographic CAD irrespective of DM. Therefore, subjects with MO but normal weight (MONW) should be carefully examined for angiographic CAD.

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1. Introduction

The prevalence and severity of obesity are dramatically increasing throughout the world. Obesity is associated with an increased risk of developing comorbidities such as non-alcoholic fatty liver disease, hypertension, type 2 diabetes mellitus (DM), coronary artery disease (CAD), stroke, and several cancers [1–3]. However, the associations between body weight and metabolic abnormalities are not straightforward. A significant proportion of subjects with obesity do not develop dysmetabolic status and conversely, dysmetabolic status can be present in lean subjects [4]. Therefore, it will become more important to distinguish obese individuals at high risk for obesity-related metabolic diseases from those who are metabolically ‘healthy’. The dysmetabolic status might be clinically important in subjects with normal weight as well.

A unique subset of obese individuals has seemed to be protected or more resistant to the development of comorbidities associated with obesity [5,6]. These individuals, now known as metabolically healthy but obese (MHO), despite having excessive body fat, display a favorable metabolic profile characterized by high levels of insulin sensitivity, no hypertension, a favorable immune profile, normal lipid, low inflammation, and beneficial hormonal profiles [7–9]. On the contrary, a subset of metabolically obese (MO) but normal weight (MONW) individuals was identified, with a potentially increased risk for developing metabolic syndrome (MetS) despite their normal body mass index (BMI) [10–12]. MHO or MONW subjects were not uncommon in the general population [13]. MHO individuals may account for as much as 20%–50% of the obese population [7,14]. There has been considerable interest recently in the establishment of clinical criteria to identify individuals who are potentially at risk for metabolic and cardiovascular complications, but there have been no comparative studies on those associations with angiographic CAD. Therefore, the aim of the present study was to compare findings of angiographic CAD according to groups by metabolic and weight status.

2. Methods

2.1. Patients

A total of 1046 subjects who had been consecutively admitted for the evaluation of angina pectoris and/or positive stress test findings were eligible for this cross-sectional study. All of them had undergone elective coronary angiography and were between the age of 25 and 80 years old. The study was carried out at St. Paul’s Hospital in Korea from October 2007 to May 2011. Subjects were excluded if

they had (1) missing baseline BMI (weight in kilograms divided by the square of the height in meters) or information about metabolic components; (2) acute ST-elevation myocardial infarction; (3) previous history of revascularization; (4) acute congestive heart failure; (5) serious noncardiac comorbid disease and infectious disease (and/or high sensitive C-reactive protein, Hs-CRP > 10 mg/dL). After these eliminations, a total of 856 subjects were included in the present analysis.

The study protocol was approved by the institutional review boards (IRB) of our institution, and it was conducted according to the Declaration of Helsinki. Written informed consent was skipped under approval of IRB.

2.2. Classification according to metabolically obese and weight status

Normal weight was defined as BMI (kg/m^2) < 25 ($n=450$; 52.6%) and obesity was defined as BMI ≥ 25 ($n=406$; 47.4%) according to the Asia-Pacific criteria for obesity [15]. We did not form a separate analysis group for “underweight” subjects (BMI < 18.5) because only 6 subjects met this definition, and the results were essentially unchanged when these subjects were excluded.

The MO was determined using the National Cholesterol Education Program-Adult Treatment Panel III classification with Korean-specific cutoffs for abdominal obesity [16–19]. The MO is defined as the presence of 3 or more of the following five metabolic components: 1) waist circumference ≥ 90 in men and 85 cm in women [20]; 2) high-density lipoprotein cholesterol (HDL-C) < 40 mg/dL in men and 50 mg/dL in women; 3) triglyceride (TG) ≥ 150 mg/dL; 4) blood pressure $\geq 130/85$ mmHg or treatment of hypertension; and 5) fasting blood glucose (FBS) ≥ 100 mg/dL or treatment of type 2 DM [21].

We categorized subjects into four groups according to MO and weight status as follows: (1) metabolically healthy and normal weight (MHNW) group; (2) MONW group; (3) MHO group; and (4) metabolically abnormally obese (MAO) group.

Height was measured to the nearest 0.1 cm using a standard stadiometer. Weight was measured, in light clothes, to the nearest 0.1 kg using a set of standard calibrated electronic scales. Waist circumference (WC) and hip circumference (HC) were measured using a constant-tension tape. WC was measured at the midpoint between the lowest rib and the upper point of the iliac crest and at the end of normal expiration. HC was measured at the maximum protrusion of the buttocks. Anthropometric measurements, such as height, weight, WC, and HC, were examined by trained nurses who were blind to patient’s information in a laboratory center. Laboratory findings were recorded by the physicians who were also blind.

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