Atherosclerosis 248 (2016) 190–195

Contents lists available at ScienceDirect

Atherosclerosis

journal homepage: www.elsevier.com/locate/atherosclerosis

The relationship between coronary atherosclerosis and body fat distribution measured using dual energy X-ray absorptiometry

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ARTICLE INFO

Article history:
Received 8 April 2015
Received in revised form
24 February 2016
Accepted 10 March 2016
Available online 17 March 2016

Keywords:
Body fat distribution
Obesity
Atherosclerosis
Gensini score

ABSTRACT

Objective: Body fat distribution is closely related to cardiovascular diseases. We aimed to evaluate the relationship between truncal fat distribution and the extent of coronary atherosclerosis.

Methods: Total body fat and regional body fat distributions were measured using dual-energy X-ray absorptiometry (DXA) in 746 Korean patients who underwent coronary angiography. The ratios of truncal fat mass to total body fat mass (FM_{trunk}/FM_{total}), truncal fat mass to fat mass in both legs (FM_{trunk}/FM_{leg}) and truncal fat mass to fat mass in both arms (FM_{trunk}/FM_{arm}) were calculated as representative parameters for truncal fat accumulation. The extent of coronary atherosclerosis was assessed using the Gensini score.

Results: The mean Gensini score of the patients was 21.3 ± 24.4. FM_{trunk}/FM_{total}, FM_{trunk}/FM_{leg} and FM_{trunk}/FM_{arm} revealed positive correlations with the Gensini score ($r = 0.242$, $p < 0.001$; $r = 0.219$, $p < 0.001$; $r = 0.133$, $p < 0.001$, respectively). In contrast, body mass index (BMI) and total body fat mass did not correlate with the Gensini score. On multiple regression analysis, FM_{trunk}/FM_{total} was associated with the Gensini score independently of age, gender, BMI and major risk factors of coronary heart disease ($B = 0.039$, $p < 0.001$).

Conclusion: Truncal fat distribution is associated with the extent of coronary atherosclerosis and more clinically relevant to that compared with total body fat or BMI in Korean patients.

1. Introduction

Obesity is related to a person's general health, especially cardiovascular health, and has been associated with hypertension, heart failure and coronary heart disease [1]. Several reports suggest that obesity results in more morbidity than does smoking, alcoholism or poverty and may be the most important cause of preventable death in the near future [1–3].

Obesity can be assessed by several indices. Body mass index (BMI) is a simple, widely used indicator that has been closely related to the development and progression of cardiovascular diseases [4,5]. However, several investigations showed that central obesity had greater clinical relevance in terms of cardiovascular risk than did BMI due to it does not reflect body fat distribution and differs between countries and ethnicities. Even in patient population with similar BMI or body weight, the distribution of body fat contributes to the risk or prevalence of cardiovascular diseases; specifically, central fat accumulation is an important factor that increases the risk of cardiovascular diseases [6–8]. In addition, epicardial adipose tissue (EAT) was proposed as an emerging risk factor for coronary artery disease (CAD) in recent studies [9]. However, evidence of a direct relationship between body fat distribution in the trunk and severity of coronary atherosclerosis is lacking particularly in East Asians.

Dual energy X-ray absorptiometry (DXA) is a reliable tool used to measure body fat distribution with minimal exposure to

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http://dx.doi.org/10.1016/j.atherosclerosis.2016.03.014
0021-9150/

radiation. Initially, DXA was used to measure bone density and total body composition, but recent developments in software now allow the determination of regional fat mass. DXA can reliably measure central fat and is comparable to computed tomography (CT), a gold standard imaging modality for quantitative measurements [10,11]. Furthermore, DXA has the unique advantage of measuring the relative distribution of body fat in a region of interest, as it scans the whole body and measures total as well as various regional body fat.

In the present study we evaluated whether the extent of coronary atherosclerosis is associated with body fat distribution, especially truncal fat distribution when measured using DXA in Korean patients.

2. Methods

2.1. Patients

From January 2005 to June 2008, 746 patients suspected of ischemic heart disease who underwent coronary angiography and DXA for evaluating body fat distribution were enrolled from the Ajou University Hospital coronary registry database. This cross-sectional study was approved by the institutional review board.

2.2. Laboratory and anthropometric measurements

We analyzed laboratory findings including lipid profiles obtained within 24 h before coronary angiography. Anthropometric measurements of the patients were obtained at the time of performing DXA, and BMI was calculated by dividing weight (kg) by height (m^2).

2.3. DXA assessment

The permeable capability of an X-ray depends on the thickness, density and chemical composition of a tissue. Based on theoretical and experimental studies, DXA can estimate the mass of fat and lean tissues using high- and low-energy X-rays in body regions without bone [12].

Using DXA (Lunar Expert™, Madison, WI, USA), total and regional body compositions including total bone mineral content, body lean mass, fat mass and fat percentage were obtained as well as body fat mass in specific areas. The truncal fat mass consisted of fat component within the area bordered by a horizontal line below the chin, vertical borders lateral to the ribs and horizontal lines passing through both iliac crests. The arm fat mass was limited by cuts that cross the lateral border of the ribs, as close to the body as possible. The leg region was designated by an upper border of both hip joints and lower border of the feet (Fig. 1). To evaluate truncal fat distribution, the ratios of truncal fat mass to total fat mass (FM_{trunk}/FM_{total}), truncal fat mass to fat mass in the legs (FM_{trunk}/FM_{leg}) and truncal fat mass to fat mass in both arms (FM_{trunk}/FM_{arm}) were calculated.

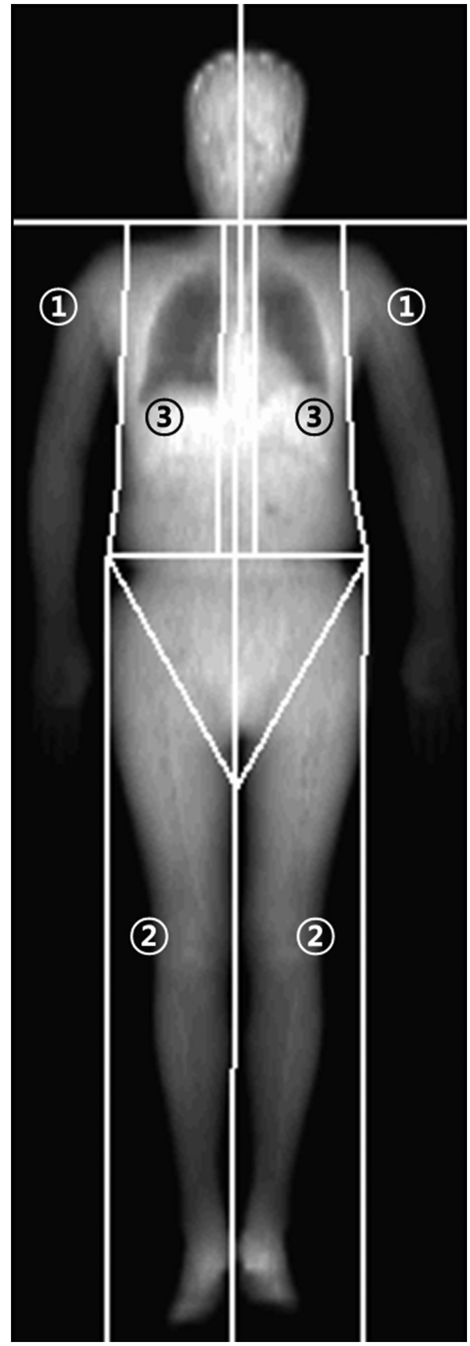

Fig. 1. Regional fat measurement by dual energy X-ray absorptiometry (DXA). ①: Arms, from lateral borders of ribs to arms; ②: Legs, from hip joints to feet. ③: Trunk, the area bordered by the chin, both iliac crests and lateral borders of ribs.

2.4. The extent of CAD analysis

After coronary angiography was performed, the extent of CAD in the entire coronary arterial tree was assessed and quantified using the Gensini score by an experienced interventional cardiologist who was blinded to the patients' demographic and DXA data. The Gensini score was designated in 1975 for the assessment of CAD severity. This is the most widely used method and based on coronary anatomy and weighted impact depending on the severity of arterial stenosis [13,14]. The functional score was based on the grade of stenosis as 1 (1–25%), 2 (26–50%), 4 (51–75%), 8 (76–90%), 16 (91–99%) and 32 points (100%) and then multiplied by a supplementary value according to the location of the diseased segment, i.e., 5 points (left main) and 2.5 points (proximal left anterior descending artery, proximal left circumflex artery). The degree of narrowing was measured using the minimal diameter of each stenotic lesion on at least two angiographic views; we quantified the grade of narrowing using CAAS 5.9.2 software (Pie Medical Imaging, Maastricht, The Netherlands).

2.5. Statistical analyses

All categorical variables were described as frequencies and