Nutrition, Metabolism & Cardiovascular Diseases (2015) **25**, 763–770

Available online at www.sciencedirect.com

Nutrition, Metabolism & Cardiovascular Diseases

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

Extra-media thickness and epicardial fat: Comparison of a novel carotid artery ultrasound index and a well-established cardiac magnetic resonance fat quantification method

M. Haberka [a,*], M. Sosnowski [b], J. Zuziak-Pruska [c], Z. Gąsior [a]

[a] School of Health Sciences, Medical University of Silesia, Department of Cardiology, Katowice, Poland
[b] School of Medicine, Medical University of Silesia, 3rd Department of Cardiology, Katowice, Poland
[c] Upper Silesian Medical Centre, Medical University of Silesia, Department of Diagnostic Imaging, Katowice, Poland

Received 12 February 2015; received in revised form 18 April 2015; accepted 30 April 2015
Available online 10 May 2015

KEYWORDS
Cardiac magnetic resonance;
Epicardial fat;
Extra-media thickness;
Metabolic syndrome;
Obesity

Abstract *Background and Aim:* Epicardial and pericardial fat are well-established surrogate markers of cardiovascular diseases and complications. Extra-media thickness (EMT) is a novel ultrasound index corresponding to arterial adventitia and adipose tissue. We aimed to evaluate the association between carotid EMT and epicardial fat (EF) and pericardial fat (PF) and their relation to cardiovascular risk and metabolic syndrome (MS).
Methods and Results: One hundred consecutive patients (age: 51.7 ± 15.4 years; males 70%) scheduled for cardiac magnetic resonance (CMR) were prospectively included in the study. Anthropometric parameters, CMR indices of EF and PF, both common carotid arteries EMT, and ultrasound indices of visceral and subcutaneous fat were measured in patients. In our study group, 53% of patients represented a very high cardiovascular risk, overweight or obesity was found in 68%, high body fat in 45%, and MS in 59% of individuals. Mean EMT (662 ± 129 μm) was significantly associated with EF area ($r = 0.46$; $p < 0.001$) and PF area ($r = 0.3$; $p < 0.001$). Among all fat indices, only EMT (MS+ 736 ± 140 μm vs. MS-658 ± 97 μm; $p = 0.002$) and EF area (MS+ 870 ± 451 mm^2 vs. MS 668 ± 333 mm^2; $p = 0.02$) were significantly increased in patients with MS compared with individuals without MS. Multivariable regression analysis also showed that mean EMT is independently associated with number of cardiovascular risk factors ($b = 0.005$; $p < 0.001$). Moreover, very high cardiovascular risk subjects showed significantly increased EMT/BMI ($p < 0.001$) and EF area/BMI ($p = 0.03$) ratios. However, there was no significant association between EMT/BMI and EF area/BMI values ($p =$ ns).
Conclusions: Our study showed the first findings on the relations between a novel ultrasound index EMT and EF assessed in a reference method of CMR. Carotid EMT may be a new surrogate marker, including both periarterial fat as a major component and arterial adventitia, which may provide additional data on cardiometabolic risk beyond that derived form a well-established EF alone.

* Corresponding author. Ziołowa 45/47, 40-635, Katowice, Poland. Tel.: +48 322527407; fax: +48 322523032.
E-mail address: mhaberka@op.pl (M. Haberka).

http://dx.doi.org/10.1016/j.numecd.2015.04.011
0939-4753/

Introduction

Obesity and metabolic syndrome (MS) are major risk factors of cardiovascular diseases and metabolic dysfunction in most countries worldwide. However, the rate and advancement of obesity-related complications vary greatly among obese individuals despite a similar grade of obesity [1]. Thus, cardiovascular (CV) risk stratification in obese patients is complex and difficult [2].

Recent studies have provided evidence that precise body fat quantity, its distribution, amount of particular fat depots, or adipocyte tissue function may partially explain this diversity in obesity. Researchers have especially focused its interest on paracardial (epicardial (EF) and pericardial (PF)) fat tissue [3]. Epicardial and pericardial adipose tissue are two fat depots characterized with a different distribution, function, vascularization, and origin. Due to their close relationship with myocardium and the common coronary blood supply, recent studies have focused on EF, exploring its complex role in the cardiovascular system [4,5]. Increased amount of EF is associated with obesity, dyslipidemia, insulin resistance, diabetes, hypertension, MS, and the presence or severity of atherosclerosis. Among the several suggested correlations between EF and cardiovascular risk factors or diseases, some are independent from general obesity [6].

Common carotid artery extra-media thickness (EMT) measurement has recently been developed as a novel ultrasound parameter of arterial adventitia [7,8]. Anatomic tissue specimens and our study in a group of high and a very high CV risk patients showed that carotid EMT was also associated with general and regional obesity with uncertain relation with echocardiography indices of EF and PF [9,10]. Therefore, we designed another study to evaluate the association between ultrasound EMT and EF and PF assessed in cardiac magnetic resonance (CMR), a reference method of PF quantification. We also examined and compared the relationship between those indices and CV risk factors and MS.

Methods

Study group characteristics

One hundred five consecutive patients scheduled for planned cardiac magnetic resonance imaging (CMR) were prospectively screened and 100 patients were included in the study. All patients were sent for CMR based on clinical indications and five patients were excluded for cardiac conditions hindering reliable measurement of paracardial adipose tissue (pericardial effusion, complex congenital heart defect or heart tumor). Subjects were recruited and completed the study in the Upper Silesian Medical Centre, Medical University of Silesia and the study protocol was approved by the local Medical University of Silesia Ethic Committee.

Assessing clinical characteristics and obesity

Hypertension was determined based on blood pressure (BP) levels (systolic BP $\geq$ 140 mmHg and/or diastolic BP $\geq$ 90 mmHg) or report of a prior diagnosis of hypertension and current antihypertensive treatment. The diagnosis of hyperlipidaemia was defined as abnormal plasma lipid levels (total cholesterol >190 mg/dl, LDL cholesterol >115 mg/dl, triglycerides >150 mg/dl, HDL cholesterol <40 mg/dl in men and <50 mg/dl in women) or prior diagnosis and current treatment [11]. All patients (except for individuals with prior diagnosis and current treatment) were screened for diabetes, which was determined based on fasting plasma glucose levels ($\geq$126 mg/dl) and HbA1c ($\geq$6.5%) and in case of discrepancies: 2-h post-load plasma glucose ($\geq$200 mg/dl) [12,13].

All the patients had a clinical assessment of adiposity. Overweight and obesity were classified according to body mass index (BMI = body mass (kg)/height(m)^2): normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2) and obesity ($\geq$30.0 kg/m^2): class 1 (30.0–34.9 kg/m^2), class 2 (35.0–39.9 kg/m^2) and class 3 ($\geq$40.0 kg/m^2). Increased waist circumference (WC) was defined according to International Diabetes Federation criteria (IDF: females$\geq$80 cm and males$\geq$94 cm). Moreover, skinfolds measurements were taken twice at 3 sites on the right side of the body as described by Jackson and Pollock [14] and averaged values were added together (3ST). The bioelectric impedance analysis (BIA, Bodystat 1500) was used to assess the patients' body fat percentage (BF%) according to the manufacturer's manual. The intra-observer variability of measurements in the same patient was <1%.

All the enrolled patients were screened for the metabolic syndrome (MS). According to the International Diabetes Federation consensus, patient with MS must have abdominal obesity (WC: females$\geq$80 cm and males$\geq$94 cm) and two of the following: raised triglycerides (TG $\geq$ 150 mg/dl or treatment), reduced HDL cholesterol (HDL-C<40 mg/dl in men and <50 mg/dl in women or treatment), raised blood pressure or specific treatment, raised fasting plasma glucose or diagnosed type 2 diabetes [15].

Ultrasound examination – carotid artery EMT, indexes of subcutaneous and visceral adipose tissue

Patients rested in a supine position before an ecg-gated ultrasound examination of both carotid arteries for EMT using a high-resolution ultrasound (GE Vivid 9, Milwaukee, US) with a linear transducer (9–12 MHz). All the images were recorded with a consecutive numbers by one experienced researcher using constant settings and ultrasound protocol of acquisition. Once the study was finished, single images showing the region of interest were randomly analyzed offline blinded to patient's data as previously described [10]. Briefly, EMT of both common carotid arteries (CCA) was measured as a distance between the carotid media-adventitia border and the jugular wall–lumen interface with visualization of the zoomed interface between the near wall of the distal segment of the CCA and neighbouring jugular vein. All the images were analyzed offline blinded to the patient's data by one