Contents available at ScienceDirect

Diabetes Research and Clinical Practice

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

International Diabetes Federation

Sarcopenia associated with renal function in the patients with type 2 diabetes

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ARTICLE INFO

Article history:
Received 19 January 2016
Received in revised form
9 May 2016
Accepted 6 June 2016
Available online 18 June 2016

Keywords:
Sarcopenia
Type 2 diabetes mellitus
Muscle mass
Glomerular filtration rate
Urinary albumin-to-creatinine ratio

ABSTRACT

Aims: Studies have suggested that low muscle mass is associated with declining renal function in healthy populations, whether the association is relevant to patients with type 2 diabetes is not well understood. This study investigates the association between sarcopenia and estimated glomerular filtration rate (eGFR) and urinary albumin-to-creatinine ratios (UACR) in the patients with type 2 diabetes.

Methods: Two recruited groups consisted of 793 persons without diabetes (males/females = 550/243) and 762 persons with type 2 diabetes (males/females = 501/261).

Results: The non-sarcopenia population demonstrated higher ASM/HT^2, GFR ($P < 0.001$) and lower UACR ($P < 0.05$) than the sarcopenia population. In studied men, the association between ASM/HT^2 and eGFR was statistically significant in the group without diabetes (OR = 0.580, $P = 0.020$), a trend which persisted in women (OR = 0.491, $P = 0.014$). The association between ASM/HT^2 and UACR persisted in studied women of two groups (OR = 0.269, $P = 0.005$; OR = 0.405, $P = 0.008$, respectively). The highest quartile of ASM/HT^2 in the non-sarcopenia population exhibited a 3.753-fold risk of abnormal eGFR within the diabetes group (OR = 3.753, $P = 0.020$). The cutoff point of ASM/HT^2 to indicate abnormal renal function for population with non-sarcopenia was 6.32 kg/m^2 in the group without diabetes and 6.31 kg/m^2 in diabetes group.

Conclusions: Sarcopenia is associated with declining renal function, which induces lower eGFR and higher UACR. In the non-sarcopenia population, ASM/HT^2 presents as renal function risk factor, which perhaps associated with higher muscle mass to induce a greater underestimation for creatinine and urinary albumin.

1. Introduction

Sarcopenia represents a true "geriatric syndrome"; it is a condition which affects more than 50% of the population of 80 years or older, and is linked to multiple causations including the aging process itself, genetic susceptibility, certain life habits, changes in living conditions and multiple chronic diseases. Sarcopenia induces poor health outcomes such as mobility disorders, disability, poor quality of life, and even death [1]. Baumgartner [2] initially proposed the diagnos-

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http://dx.doi.org/10.1016/j.diabres.2016.06.023
0168-8227/

tic criteria for sarcopenia, defined as the possession of an appendicular skeletal muscle mass (kg)/height^2 (m^2) less than two standard deviations below the mean of a young reference group. Avers et al. [3] reported that muscle weakness (sarcopenia) is a normal phenomenon related to advanced age, which increases at a rate of 1–5% annually, beginning at the age of 30. Age-related sarcopenia inhibits mobility, thus increasing the risk for developing many diseases, including diabetes, arthritis, osteoporosis, and heart disease [4]. Several recent studies have suggested that increasing body fat and distribution induces a decline in eGFR and chronic kidney disease in non-diabetic populations [5–11]. Previous studies have shown that an increase in fat mass presents as a risk factor for eGFR, independent of whether the simultaneous increase in muscle mass is beneficial to kidney function. Chew-Harris et al. [12] reported that men with greater muscle mass demonstrated higher GFR within the non-diabetic population. It is not well understood whether muscle and kidney function are related in type 2 diabetics. Therefore, the aim of the present study is to investigate the association between sarcopenia and renal function in the persons with type 2 diabetes.

2. Material and methods

2.1. Study population

A total of 762 patients with type 2 diabetes were recruited from the Endocrinology Department at the First Affiliated Hospital of Fujian Medical University, from March 1, 2007 to November 30, 2014; the type 2 diabetes study population included 501 males and 261 females. A total of 793 persons without diabetes were recruited from the Medical Center at the First Affiliated Hospital of Fujian Medical University from September 1, 2008 to February 28, 2015; the non-diabetic study population included 550 males and 243 females. Exclusion criteria included the presence of any of the following: type 1 diabetes, gestational diabetes, diabetic ketoacidosis, hyperosmolar nonketotic comas, hepatic disease, heart disease, thyroid disease, long-term use of anti-inflammatory or hormone drugs. The ethics committee of the First Affiliated Hospital of Fujian Medical University approved the present study, and written consent was obtained from all study participants.

2.2. Measurements

The following factors were measured in all study participants after ten hours of overnight fasting: serum creatinine (Scr), total cholesterol (TCH), triglycerides (TG), high-density lipoprotein cholesterol (HDL-c) and low-density lipoprotein cholesterol (LDL-c). Glycated hemoglobin A1c (HbA1c) was measured by high-performance liquid chromatography (HPLC) (VARIANTTM II, BIO-RAD, Hercules, CA, USA). Glomerular filtration rate was estimated according to the following equation: $eGFR = 186 \times SCr\ (mmol/L)^{-1.154} \times age^{-0.203}$ ($\times 0.724$ female). Urinary albumin-to-creatinine ratio (UACR) (mg/g) was calculated by dividing the urine albumin content by the urine creatinine content, following morning urine collection. Blood pressure was measured after a 15-min rest. Body weight and height were measured with the patient in light clothes and without shows. Body mass index (BMI, kg/m^2) was calculated by dividing the body weight by the height squared (kg/m^2). Body composition was determined by dual energy X-ray absorptiometry (DEXA, Lunar Prodigy scanner, GE Lunar Corporation, Madison, WI, USA). Physical activity was defined by guidelines published by the American Diabetes Association, as follows: people with diabetes should be advised to perform at least 150 min/week of moderate-intensity aerobic physical activity (50–70% of maximum heart rate); in the absence of contraindications, people with type 2 diabetes should be encouraged to perform resistance training three times per week.

2.3. Diagnostic criteria

The diagnostic criteria for sarcopenia was determined as follows: demonstration of appendicular skeletal muscle mass (kg)/height^2 (m^2) less than two standard deviations below the mean of a young reference group. The ASM/HT^2 cutoff points were 7.26 kg/m^2 and 5.45 kg/m^2 for men and women, respectively, as was initially proposed by Baumgartner in 1998 [2]. Type 2 diabetes was defined according to the criteria established by the American Diabetes Association in 2010 [13]. Diagnosis of hypertension was delivered in accordance with the JNC 7 report [14] which included patients with antihypertensive treatment or a systolic blood pressure $\geqslant$140 mmHg, and/or a diastolic blood pressure $\geqslant$90 mmHg on at least two occurrences directly following a rest period of 15 min. Abnormalities in albumin excretion are adopted as those defined by the National Kidney Foundation, and physical activity levels were adopted as those defined by the American Diabetes Association [13].

2.4. Statistical analysis

Statistical results are presented as mean ± SD, median (range) or percentages, Mean comparisons between study groups were achieved by using a chi-square test for categorical variables, and by *t*-test for continuous variables. Stratified analyses were conducted to examine interactions according to the following qualifications: eGFR ($\geqslant$90, 60–89, <60) and UACR (<30, 30–299, $\geqslant$300). Spearman's correlation analysis was performed to explore the relationship between UACR, eGFR and muscle mass. Correlational analysis, multiple linear regression analysis and dual logistic regression analysis were performed to examine the association between AMM/HT^2 and eGFR, and between AMM/HT^2 and UACR. Statistical tests were two-sided; a p-value < 0.05 was considered to represent statistical significance. All statistical analyses were performed with SPSS statistical software, version 11.0.

3. Results

3.1. Participant characteristics

The baseline characteristics of all participants are recorded in Table 1. In the population without diabetes, ages ranged from 21 to 82 years old (mean = 52.47 ± 10.68 years and 53.12 ± 10.72 years, respectively); in the group with diabetes, ages ranged from 24 to 79 years (mean = 51.53 ± 9.00 years and