ORIGINAL RESEARCH

Body Composition and Mortality in Coronary Artery Disease With Mild Renal Insufficiency in Chinese Patients

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Objective: Obesity is a risk factor for both coronary artery disease (CAD) and chronic renal insufficiency (RI); patients with CAD are prone to obesity and RI. In this study, we try to analyze the effect of body composition on death in CAD patients with mild RI.

Design: Retrospective cohort study.

Subjects: A total of 1,591 consecutive CAD patients confirmed by coronary angiography were enrolled and met the mild RI criteria by estimated glomerular filtration rate: 60-90 mL/min.

Main Outcome Measurements: The influence of body composition on mortality of CAD was detected in different body compositions, including body mass index (BMI), body fat (BF), and lean mass index (LMI). The end points were all-cause mortality. Cox models were used to evaluate the relationship of quintiles of body compositions with all-cause mortality.

Results: A survival curve showed that the risk of death was higher in the low BMI group than in the high BMI group (log-rank for overall $P = .002$); LMI was inversely correlated with risk of death, such that a lower LMI was associated with a higher risk of death (log-rank for overall $P < .001$). No significant correlation was observed between BF and risk of death. Multifactorial correction show that LMI was still inversely correlated with risk of death (quintile 1: reference; quintile 2: hazard ratio [HR]: 0.49, 95% confidence interval [CI]: 0.26-0.92; quintile 3: HR: 0.35, 95% CI: 0.17-0.70; quintile 4: HR: 0.41, 95% CI: 0.20-0.85; quintile 5: HR: 0.28, 95% CI: 0.12-0.67).

Conclusion: For CAD patients with mild RI, BMI or BF was unrelated to risk of death, while LMI was inversely correlated with risk of death. A weak "obesity paradox" was observed in this study.

Introduction

WITH THE CHANGES in modern lifestyles, obesity is becoming an important issue affecting health.[1] Obesity is a risk factor for many diseases; in the general population, a high body mass index (BMI) is associated with a high risk of cardiovascular disease and death.[2-4] In contrast, for many chronic diseases, obesity is inversely correlated with the risk of death, presenting an "obesity paradox."[5-7] Previous studies have shown that the obesity paradox exists in patients with renal insufficiency (RI). However, most of these studies were conducted in patients with intermediate to advanced RI or in patients receiving dialysis.[8,9] Few studies have been conducted to investigate the effect of obesity in patients with early RI. Some studies have reported that the obesity paradox can be observed during secondary prevention for patients with coronary artery disease (CAD)[10,11]; however, researchers have reached different conclusions.[12,13] Comorbid RI is a risk factor for death in CAD patients.[14] Studies have shown that the risk of death is significantly higher in CAD patients with even mild RI compared with patients with normal renal function.[15,16] RI and obesity often coexist in CAD patients, but the role of obesity in CAD patients with mild RI and the presence of the obesity paradox in these patients are unknown.

In this study, we evaluated patients' body fat (BF) condition using body composition parameters such as BMI, BF, and lean mass index (LMI) and analyzed the effect of BF condition on the risk of death in CAD patients with mild RI.

Methods

Study Population

The data source for this investigation was the CAD database of our hospital. This single-center database prospectively includes all the CAD or high-risk patients

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undergoing angiography in our hospital. For this analysis, we enrolled consecutive patients with CAD from July 2008 to January 2012 of the database. Patients with CAD were eligible for inclusion if they were restricted to participants with angiographic evidence of ≥50% stenosis in ≥1 coronary vessels. The exclusion criteria included malignancies, pregnancy, and severe liver or hematological diseases. These inclusion and exclusion criteria were met by 3,365 continuously enrolled CAD patients. We further excluded subjects with (1) patients with loss of follow-up (n = 287); (2) incomplete follow-up data (n = 89); (3) estimate glomerular filtration rate (eGFR) < 60 mL/min or ≥ 90 mL/min (n = 1,398). Finally, 1,591 patients were included in the data analysis. The study protocol was approved by the local institutional review boards in accordance with the Declaration of Helsinki. All subjects provided written informed consent before enrollment.

Baseline Characteristics

Demographic data, medical history, cardiovascular risk factor, vital signs at admission, medication at discharge, and final diagnosis were obtained from the patients' electronic medical records and reviewed by a trained study coordinator. Blood sample were collected before angiography, and plasma biomarkers including liver and kidney function (including the admission serum creatinine levels), blood glucose, serum lipid, etc. were analyzed in the department of Laboratory Medicine of our hospital, accredited by the College of American Pathologists. Hypertension was defined as those with systolic blood pressure ≥ 140 mm Hg and/or diastolic blood pressure ≥ 90 mm Hg and/or those receiving antihypertensive medications. Diabetes mellitus was diagnosed in patients who had previously undergone dietary treatment for diabetes, had received additional oral antidiabetic or insulin medication, or had a current fasting blood glucose level of ≥7.0 mmol/L or random blood glucose level ≥11.1 mmol/L. Patients received care according to the usual practice; treatment was not affected by participation in this study.

Body Composition Assessment

During hospitalization, body height and weight of the patients were measured by nurses using standard methods. BMI was calculated as weight (kg) divided by the square of height (m^2). BF was estimated using the Clínica Universidad de Navarra—Body Adiposity Estimator equation: $BF = -44.988 + (0.503 \times age) + (10.689 \times sex) + (3.172 \times BMI) - (0.026 \times BMI^2) + (0.181 \times BMI \times sex) - (0.02 \times BMI \times age) - (0.005 \times BMI^2 \times sex) + (0.00021 \times BMI^2 \times age)$, where sex is replaced by 0 for male and 1 for female individuals.[17] This formula has been validated in a large population.[18] The LMI was calculated as follows: (1 − % BF) × BMI kg/m^2.[19] As no reference value has been reported in a Chinese population, we divided the study patients into five groups according to the quintiles of sex-specific BMI, LMI, or BF.

Renal Function Assessment

Serum creatinine was finished before the angiography within first 24 hours after admission and assessed by a non-kinetic alkaline picrate (Jaffe) method. The Modification of Diet in Renal Disease equation was used to eGFR in milliliters per minute per 1.73 m^2.[20] We preserved the patients with mildly RI (stage 2, 60 mL/min ≤ eGFR < 90 mL/min) in this study and exclude normal renal function (stage 1, eGFR ≥ 90 mL/min) and moderately or severely RI (Stage 3-5, eGFR < 60 mL/min), corresponding to strata used to define chronic kidney disease (CKD) stages.[21]

Follow-up and End Points

The follow-up period ended on January 2013. Follow-up information was collected through contact with patients' physicians, patients, or their family. All data were corroborated with the hospital records. The primary end points in this study were all-cause mortality as documented in the database.

Statistical Analyses

We conducted the post hoc analysis on a retrospective basis. Baseline demographics and clinical characteristics were compared among patients categorized by the survivors and deaths in two groups. Continuous variables were expressed as the mean ± standard deviation, and categorical variables were reported as counts and percentages. Analysis of *t* test and chi-squared tests were used to test for differences between groups for continuous and categorical variables, respectively. To determine the association between body compositions and all-cause mortality, Kaplan–Meier curves by body composition quintiles were constructed and examined using the log-rank test for comparison, respectively. Hazard ratios (HRs) and 95% confidence intervals (CIs) were calculated based on Cox proportional hazards regression models, which was used to investigate the independent effect of body compositions on the outcome events. Adjustments were made for the possible confounding effects of age, sex, medical history (prehypertension and prediabetes mellitus), admission examination (systolic blood pressure and heart rate), heart function (Killip level), diagnosis of acute coronary syndrome, discharge medications (statin, angiotensin-converting enzyme inhibitors or angiotensin-receptor blockers, and beta-receptor blockers). Two-sided *P* values of less than .05 indicated statistical significance. All analyses were performed with SPSS software (version 19.0).

Results

A total of 1,591 CAD patients with mild RI were included in the study. The mean patient age was 65.7 ± 9.6 years old, and 19.9% of the patients were women. The average BMI was 24.3 ± 2.9; the average