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Original article

The impact of metabolic parameters on the change of pulmonary function in obese patients

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Abstract

Background: Ethnic differences exist in the function and distribution of adipose tissue, which influences whole body metabolism, including pulmonary function. The object of this study was to examine the relationships between serum metabolic parameters and pulmonary function in a morbidly obese Asia-Pacific population.

Methods: One-hundred thirty-seven morbidly obese Chinese patients, aged ≥18 years with a body mass index (BMI) >32 kg/m^2 who were being evaluated for bariatric surgery between July 2007 and December 2008, were studied. Cross-sectional associations between serum metabolic parameters, including lipids, glucose, insulin, leptin, and adiponectin levels with forced vital capacity (FVC) and forced expiratory volume in the first second (FEV_1) assessed by spirometry, were analyzed. Multiple regression analyses also were conducted, with age, gender, smoking history, and various anthropometric measurements of obesity as confounders.

Results: Serum adiponectin and HDL cholesterol had a positive correlation with FVC and FEV_1. In addition, insulin resistance, determined by the homeostatic model assessment method (HOMA), was negatively correlated with FVC. In the multiple linear regression analysis, only serum adiponectin was significantly correlated with FVC and FEV_1, independent of obesity level.

Conclusions: Serum adiponectin level was positively and independently associated with pulmonary function in morbidly obese Chinese adults. (Surg Obes Relat Dis 2014;10:23–28.)

Keywords: Adiponectin; Morbid obesity; Pulmonary function test; Visceral Adipose tissue; Waist circumference

Adipose tissue plays a central role in lipid and glucose metabolism through the production of several cytokines and hormones, including leptin and adiponectin [1,2]. Adipose tissue dysfunction and obesity have been linked to the development of cardiovascular disease, diabetes, metabolic syndrome, and increased all-cause mortality in various populations [3,4]. Obesity, especially abdominal obesity, can also lead to a restrictive pattern of impaired pulmonary function [5–7]. In addition, restrictive pulmonary function impairment also is found in patients with diabetes, impaired glucose tolerance (IGT), cardiovascular disease, and metabolic syndrome [7–10]. Furthermore, a longitudinal study suggested that a restrictive pattern of pulmonary function, as assessed with a single spirometric test, was associated with increased morbidity and mortality [11]. However, the potential mechanism(s) underlying these associations remain unclear.

Various serum metabolic parameters and biomarkers have been used to clarify the clinical relationships between

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restricted pulmonary function and metabolic disturbance and associated morbidity. Previous nested case-control and population-based studies reported a negative association between serum leptin and pulmonary function [12,13]. A translational epidemiologic study that included black and white patients found that lower serum adiponectin concentrations are associated with lower pulmonary function in young adults [14]. Another large cross-sectional study conducted in the United States indicated that forced expiratory volume in 1 second (FEV_1) was positively associated with HDL cholesterol levels and negatively associated with LDL cholesterol levels [15]. However, ethnic differences in adipose tissue distribution and levels of obesity markers may contribute to different chronic disease risks and related metabolic disorders across ethnic groups [3,16,17]. Several studies suggest that Asia-Pacific cohorts have a relatively higher amount of visceral adipose tissue (VAT) in comparison to Europeans or Caucasian populations [18–20]. The cross-sectional and longitudinal associations among various anthropotric and metabolic parameters with pulmonary function have not been adequately examined in an Asia-Pacific population, especially in morbidly obese patients.

The aim of this study was to clarify the relationship between the metabolic parameters (including insulin resistance, circulating lipids, glucose, insulin, leptin, and adiponectin levels) and pulmonary function in morbidly obese patients. The level of obesity also was included in the study to examine the effects of obesity and metabolic parameters on pulmonary function.

Materials and methods

Study population

Patients ≥ 18 years with a body mass index (BMI) > 37 kg/m^2, or between 32 and 37 kg/m^2 with obesity-related co-morbidities who were being evaluated for bariatric surgery at the obesity center of a university hospital in southern Taiwan between July 2007 and December 2008, were enrolled in this study. The inclusion criteria were adopted from a modification of the recommendations of the Asia-Pacific consensus. Patients were excluded if they had any of the following conditions: a history of chronic or active lung disease such as asthma or bronchitis, pregnancy, endocrinopathy-induced obesity, or any type of malignancy. Informed written consent to participate in the study was obtained from each patient before surgery. The study protocol was approved by the Human Ethics Committee of the university hospital.

Measurements of anthropometric parameters of obesity

Weight (W, in kilograms) and height (in meters) were measured after overnight fasting. BMI was calculated as weight/height^2 (in kg/m^2). A D-loop nonstretch fiberglass tape was used for waist and hip circumference measurements. Waist circumference (WC) was measured at the midpoint between the lower border of the rib cage and the iliac crest while the patient was standing with the abdomen relaxed at the end of normal expiration, with both feet touching and arms hanging freely. Among patients with no natural waistline, the measurement was taken at the level of the umbilicus.

Measurements of metabolic parameters and biomarkers

Overnight fasting blood samples were collected and serum glucose, total cholesterol, HDL-C, LDL-C, and triglyceride (TG) levels were measured with a commercially available automated biochemical analyzer (Architect c16000, Abbott Diagnostics, Lake Forest, IL). Serum was frozen at -80°C for later measurement of adiponectin and leptin. Serum adiponectin concentration was measured using a commercially available enzyme immunoassay kit (Phoenix Pharmaceuticals, Burlingame, CA), and serum leptin concentration was measured using a commercially available radioimmunoassay kit (Linco Research, St Charles, MO). Serum insulin level was estimated by a radioimmunoassay kit on a Wallac 1470 Wizard Automatic Gamma Counter (GMI, Ramsey, MN). Insulin resistance was determined by the homeostatic model assessment method (HOMA), using glucose and insulin in a fasting state. HOMA was calculated as (insulin $\times$ glucose)/22.5, where insulin was expressed in μU/mL and glucose in mmol/L.

Pulmonary function testing

Pulmonary function testing (PFT) was performed with the patient in a sitting position, with nose clips in place, using a body plethysmography (Vmax 229, SensorMedics, Yorba Linda, CA). All tests were performed by the same team of technicians according to the recommendations of the American Thoracic Society/European Respiratory Society. Knudson's reference equations were used to express the predicted values of the PFT. Each participant performed at least 3 tests (with at least 2 reproducible and acceptable maneuvers). The measurements included forced vital capacity (FVC) and FEV_1. Results were considered reproducible if the second highest FVC and FEV_1 values were within 5% of the highest values. The highest measured FEV_1 value and the corresponding FVC value were coded for computer analysis. The results of these tests were expressed as the percentage of the predicted normal values.

Statistical analysis

Statistical analyses were carried out with the SPSS version 19 statistical software package (IBM Corporation, Armonk, NY). Continuous parameters are presented as the mean (standard deviation [SD]), and categorical parameters