Quantifying Cardiovascular Risks in Patients With Metabolic Syndrome Undergoing Total Joint Arthroplasty

Kishor Gandhi, MD, MPH,* Eugene R. Viscusi, MD,* Eric S. Schwenk, MD,* Luis Pulido, MD,† and Javad Parvizi, MD†

Abstract: The coexistence of diabetes, hypertension, obesity, and dyslipidemia is defined as metabolic syndrome. Studies show substantial cardiovascular risks among these patients. The risk of patients with metabolic syndrome undergoing total joint arthroplasty (TJA) is unknown. Patients with and without metabolic syndrome undergoing TJA during a 3-year period were analyzed for postoperative complications. Metabolic syndrome was defined by having 3 of the following 4 criteria: obesity (body mass index ≥30 kg/m^2), dyslipidemia, hypertension, and diabetes. Patients with metabolic syndrome had a significantly higher risk of cardiovascular complications compared with controls (P = .017). The risk of an adverse event increased by 29% and 32%, respectively, when there were 3 or 4 syndrome components. Patients with metabolic syndrome undergoing TJA have increased risk for cardiovascular complications. Our results show that metabolic syndrome may have a clustering effect and pose increased risk when individual risks factors are combined. **Keywords:** metabolic syndrome, cardiovascular complications, metabolic abnormalities, risk profile, joint arthroplasty.

The concept of a related group of co-occurring metabolic abnormalities consisting of resistance to insulin-stimulated glucose uptake, glucose intolerance, hyperinsulinemia, increased triglycerides, decreased high-density lipoproteins, and hypertension was first introduced as syndrome X in 1988 [1]. Both the World Health Organization and the National Cholesterol Education Program/Adult Treatment Panel III (NCEP-ATP III) in 1998 and 2001, respectively, have proposed formal definitions of this entity called *metabolic syndrome* [2,3]. Hence, statistics on the prevalence of metabolic syndrome are largely dependent on the criteria used to define it. An estimate using the NCEP-ATP III criteria of the age-adjusted prevalence of metabolic syndrome in the United States in the year 2000 was 23.7% of those older than 20 years [4]. This represents around 47 million people in the United States.

The prevalence of metabolic syndrome has increased significantly over the past decade in all age groups and in both sexes [5]. Factors that increase the risk for developing this syndrome include older age, postmenopausal state, higher body mass index (BMI), high carbohydrate intake, and physical inactivity. Thus, the pathogenesis of metabolic syndrome is multifactorial, involving a complex interaction between sedentary lifestyle, obesity, diet, and genetic factors. The clustering of these components may pose a greater surgical risk than the sum of the individual components [2]. Studies have shown an increase in the occurrence of coronary artery disease (CAD) in both white and black patients with metabolic syndrome [6,7]. Cardiovascular morbidity and overall mortality are higher in patients with metabolic syndrome [8-13]. Furthermore, metabolic syndrome acts as a proinflammatory and prothrombotic state that may be exacerbated by the stress of surgery [7].

One study found that the risk of operative mortality in patients undergoing coronary artery bypass grafting was more than double in patients with metabolic syndrome [14]. However, the cardiovascular risk of patients undergoing total joint arthroplasty (TJA) is unknown. The primary objective of this study was to determine the incidence of postoperative cardiovascular complications

*From the *Department of Anesthesiology, Jefferson Medical College, Thomas Jefferson University, Philadelphia, Pennsylvania; and †Rothman Institute of Orthopaedics, Thomas Jefferson University Hospital, The Rothman Institute, Philadelphia, Pennsylvania.*

Submitted January 26, 2011; accepted June 30, 2011.

The Conflict of Interest statement associated with this article can be found at doi:10.1016/j.arth.2011.06.027.

Reprint requests: Kishor Gandhi, MD, MPH, Jefferson Medical College, Department of Anesthesiology, Thomas Jefferson University, 111 South 11th St, Suite 8490, Philadelphia, PA 19107.

0883-5403/2704-0004$36.00/0
doi:10.1016/j.arth.2011.06.027

after TJA. We further examined the impact of each component of metabolic syndrome (obesity, dyslipidemia, hypertension, and diabetes) on the cardiovascular complication rate.

Materials and Methods

Patient Population

After institutional review board approval of this retrospective study, all patients who underwent primary total hip or total knee arthroplasty between January 2004 and June 2007 were identified. Patients were screened for one or more components of metabolic syndrome, which is defined below. After these patients were identified, a random sample of 3000 patients without metabolic syndrome was chosen to represent the control group. This number was chosen to avoid overinflating the power of the study. All patients were seen in a preoperative evaluation clinic before surgery. Data regarding demographics, past medical and surgical histories, and medications were recorded during this evaluation. All surgical patients at our institution receive close follow-up during their hospitalization, including the recording of any postoperative complications. Cardiovascular complications that occurred during the inpatient period after surgery and up until discharge were recorded in a database that was linked to a database containing the patients' comorbidities.

The past cardiovascular comorbidities of patients were identified as independent risk factors for cardiovascular complications postoperatively. These risk factors included atrial fibrillation, arrhythmias (not otherwise specified), cardiac valve disease (mitral valve prolapse, mitral valve insufficiency, mitral valve stenosis, aortic valve insufficiency, or aortic valve stenosis), CAD, myocardial infarction (MI), congestive heart failure (CHF), cerebrovascular disease (CVD) (history of stroke or transient ischemic attacks), coagulopathies (hemophilia or factor deficiency), deep vein thrombosis (DVT), pulmonary embolism (PE), and peripheral vascular disease.

Identification of Patients with Metabolic Syndrome

The NCEP-ATP III defined metabolic syndrome as the presence of 3 of the following 5 conditions: central obesity (waist circumference >102 cm in men and >88 cm in women), serum triglyceride levels (triglycerides ≥150 mg/dL), serum high-density lipoprotein levels less than 40 mg/dL in men and less than 50 mg/dL in women, hypertension (≥130/85 mm Hg), and high fasting glucose (≥110 mg/dL). A modified definition using clinically relevant data was adopted because of the lack of availability of data on waist circumference and fasting laboratory values. Accordingly, metabolic syndrome was defined as the presence of 3 of the following 4 criteria: obesity (BMI ≥30 kg/m^2), dyslipidemia, hypertension, and diabetes. *Dyslipidemia* was defined as having a diagnosis of hypercholesterolemia or hypertriglyceridemia before surgery. *Diabetes* was defined as having a diagnosis of type 1 or 2 diabetes mellitus. *Hypertension* was defined as having a diagnosis of hypertension and was further divided into controlled (taking medications) or uncontrolled. Laboratory values, such as blood glucose and lipid profiles, were not used as part of the analysis because of the possibility that they were nonfasting values.

Primary Outcome Measured

The primary outcome measured was the occurrence of postoperative cardiovascular complications during their hospital stay. The cardiovascular complications included but were not limited to asystole, arrhythmias (not otherwise specified), atrial fibrillation, supraventricular tachycardia, bradycardia, MI, CHF, PE, DVT, pulmonary edema, and stroke. Asystole, arrhythmias (not otherwise specified), atrial fibrillation, supraventricular tachycardia, and bradycardia were identified using clinical and electrocardiographic parameters. Myocardial infarction was defined by an increase in serum troponin levels. Congestive heart failure was categorized based on clinical history and echocardiographic findings. Pulmonary edema was determined based on physical examination and imaging findings. Deep vein thrombosis was determined based on Doppler ultrasound findings. Pulmonary embolism was diagnosed based on multidetector computed tomography or ventilation-perfusion scan. The diagnosis of stroke was based on neurological evaluation and the confirmation by computed tomography or magnetic resonance imaging scan.

Statistical Analysis

All statistical analyses were conducted with the use of SPSS software (version 18.0; PASW, Chicago, Ill). All bivariate analyses were 2-tailed with $\alpha = .05$. $P < .05$ based on Pearson χ^2 analysis was considered to be significant. Results of the bivariate analysis guided the construction of the logistic regression model. χ^2 analyses of patient demographics and cardiovascular risk factors were conducted. Variables contained within multivariate analysis were only included if they were statistically significant on bivariate analysis. Multivariate logistic regression models controlling for patients' demographics (age, race, and sex), operative data, and previous cardiovascular and thromboembolic histories were created. Analysis showed the *P* value, odds ratio (OR), and the 95% confidence interval (CI) for patients with and without metabolic syndrome. Additional logistic regression models were created to quantify the cardiovascular risk of individual components of metabolic syndrome. These risk profiles were represented with OR and 95% CI. A value greater than 1 indicated that there was an increase in the risk of cardiovascular event after TJA. Odds ratios were not represented for conditions with very low occurrence in the sample population, as the model was unable to generate risks for these individual components.