Asian Ethnicity and the Prevalence of Metabolic Syndrome in the Osteoarthritic Total Knee Arthroplasty Population

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Abstract: Metabolic syndrome (MS) is a known risk factor for the development of osteoarthritis (OA). We asked whether the prevalence of MS varies across ethnicity among patients who undergo total knee arthroplasty for end-stage OA. In our population of 1460 patients undergoing primary knee arthroplasty, *MS* was defined as body mass index greater than 30 kg/m^2, diabetes, hypertension, and hypercholesterolemia. Among the 1334 white patients, 114 (8.5%) had MS as compared with 3 of 36 (8.3%) blacks and 18 of 90 (20%) Asians ($P = .006$) Adjusted analysis showed that those of Asian ethnicity had a 2.0 (95% confidence interval, 1.1-3.8; $P = .03$) times greater odds of MS as compared with those of other ethnicity. Metabolic syndrome is a risk factor for OA, and Asians demonstrate a greater prevalence of MS as compared with whites and blacks in this population. **Keywords:** metabolic syndrome, ethnicity, knee osteoarthritis, Asians.

The *metabolic syndrome* (*MS*) is defined by the findings of central adiposity, elevated fasting glucose, hypertension, and *dyslipidemia* defined by high serum triglycerides and low high-density lipoprotein (HDL) cholesterol [1,2]. Patients with at least 3 of these 5 criteria have a 1.5 to 2 times increased risk of cardiovascular disease [2]. Moreover, MS is associated with a systemic proinflammatory and prothrombotic state [1,3-5].

Many authors have documented the impact of these shared risk factors of obesity, cardiovascular disease, hypertension, and dysglycemia on the risk of osteoarthritis (OA) [6-8]. Adipose tissue is now regarded as an active endocrine organ that produces tumor necrosis factor α, interleukin-6, and C-reactive protein, which together induce a systemic proinflammatory state and mediate insulin resistance [9-11]. Insulin resistance further induces a chronic inflammatory state through increased lipolysis and elevated systemic levels of free fatty acids. Moreover, visceral adipocytes release the peptide hormone leptin that also promotes systemic inflammation [12-15]. This overall elevated inflammatory state has been linked to chondrocyte death and matrix degeneration [16,17]. Moreover, a recent hypothesis has been put forward suggesting a link between obesity-induced atherosclerosis and OA [8]. Microvascular disease, particularly in the subchondral bone, may lead to cartilage degeneration through poor cartilage nutrition and a direct ischemic insult.

In the medical literature, Asians have been shown to be at a greater risk for MS as compared with any other ethnic groups [18-20]. The prevalence of MS in Asians ranges between 15% and 50% depending on the population studied [18-20]. However, it has been suggested that, because Asians develop MS at a lower body mass index (BMI) and waist circumference than others, the prevalence may be underestimated by as much as 25% [19,21]. In large population-based studies of white patients in the United States, the prevalence of MS ranges between 10% and 22% [22,23]. The possibility of an ethnic difference in the prevalence of MS has not been explored in an OA population.

We asked whether the prevalence of MS varies across ethnicity among patients who undergo total knee arthroplasty (TKA) for end-stage OA. We hypothesized a priori that the prevalence would be greatest in Asian patients.

Patients and Methods

Patients were recruited to participate in a total joint arthroplasty registry from a single Canadian academic institution, the Toronto Western Hospital, while on a waiting list for primary knee arthroplasty. All patients gave informed consent to participate in the registry. Our inclusion criteria for this retrospective study were being at

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Submitted July 7, 2008; accepted February 4, 2009.
No benefits or funds were received in support of the study.
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0883-5403/09/2503-0014$36.00/0
doi:10.1016/j.arth.2009.02.005

least 18 years old and having a diagnosis of primary OA. The study protocol was approved by the Human Subject Review Committee.

All surgeries were performed by 1 of 3 fellowship-trained arthroplasty surgeons between the years of 1998 and 2006. All patients were included only once in the analysis even if they underwent contralateral surgery at a later date. All data were collected by an independent assessor not involved in the medical care of the patients.

Collection of Data

Baseline demographic data of age, sex, BMI, and medical comorbidity were collected by patient self-report. Education was recorded as either high education level (university or above) or low education level (high school or below).

Ethnicity was recorded by patient self-report under the categories of white, black, European, Asian, or Aboriginal. Patients could choose as many as were appropriate. We had no patients under the category of Aboriginal. Those patients selecting white or European were collapsed into a white category. Asian refers to individuals who classified themselves as South Asian (India, Pakistan, Bangladesh, and Sri Lanka) or East Asian (China, Japan, Taiwan, Korea).

Metabolic Syndrome

There is a lack of complete consensus on the definition of MS, as many debate the significance of insulin resistance. The World Health Organization (WHO) [24] defines *MS* as follows:

Insulin resistance (type 2 diabetes, impaired fasting glucose, impaired glucose tolerance)

Plus any 2 of the following:

- Elevated blood pressure
- Plasma triglyceride of at least 150 mg/dL
- HDL not exceeding 35 mg/dL (men) or not exceeding 40 mg/dL (women)
- BMI of at least 30 and/or waist/hip circumference of at least 0.9 (men) or at least 0.85 (women)
- Urinary albumin of at least 20 mg/min; albumin/creatinine of at least 30 mg/g

The American Heart Association (AHA) defines *MS* as patients having 3 or more of the following risk factors [25]:

- Increased waist circumference: men, at least 102 cm; women, at least 88 cm
- Elevated triglycerides of at least 150 mg/dL
- Reduced HDL cholesterol: men, less than 40 mg/dL; women, less than 50 mg/dL
- Elevated blood pressure of at least 130/85 mm Hg
- Elevated fasting glucose of at least 100 mg/dL

Laboratory values of cholesterol, fasting glucose, blood pressure, or waist circumference were not routinely collected as part of our registry. We classified *MS* in our study based on a BMI of at least 30 kg/m^2 and patient self-report of the diagnosis of diabetes, hypertension, and hypercholesterolemia.

Functional status and pain level were assessed preoperatively with the Western Ontario McMaster University Osteoarthritis Index (WOMAC) function and pain scores, respectively [26]. A greater score on the WOMAC scale represents poorer function or greater pain.

Statistical Analysis

Continuous data such as age, BMI, and WOMAC scores were compared between groups using *t* tests. Means and standard deviations are reported for all continuous variables. Categorical data such as sex, education, and ethnicity are reported with frequencies; and groups were compared with the Fisher exact test.

Multivariable logistic regression modeling was performed to determine the impact of ethnicity on the prevalence of MS. For this model, we collapsed the ethnicity variable into a binary term of Asian vs non-Asian. The variables entered into the model were age, sex, education, and ethnicity.

All statistical analyses were performed with SPSS version 13.0 (Chicago, IL). Odds ratios (ORs) for regression modeling and their 95% confidence intervals (CIs) are reported. All reported *P* values are 2-tailed with an α of .05.

Results

In our registry, we had complete demographic and comorbidity data on 1460 of 1625 (89.8%) patients who comprised our study cohort. Responders were not significantly different from nonresponders in age, BMI, sex, or comorbidity. The overall prevalence of MS in our cohort was 135 of 1460 (9.2%).

At the time of surgery, there were no differences between those patients with and without MS in age, sex, or baseline functional status ($P > .05$). The patients with MS had a significantly greater BMI at 32.8 kg/m^2 as compared with 30.4 kg/m^2 in those without MS. (Table 1).

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Table 1. Unadjusted Analysis Comparing Demographic and Baseline Functional Outcome Scores Between Patients With and Without MS

	MS (n = 135)	Without MS (n = 1325)	*P* Value
Mean age (SD)	66.1 (9.2)	66.6 (9.9)	.85
% Male	33.0	36.5	.57
Mean BMI, kg/m^2 (SD)	32.8 (2.1)	30.4 (6.8)	.02
Preop WOMAC scores			
WOMAC total (SD)	55.8 (15.2)	53.4 (17.9)	.16
WOMAC pain (SD)	15.3 (15.4)	10.5 (3.8)	.63