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Perioperative Complications in Patients With Sleep Apnea Undergoing Total Joint Arthroplasty

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ABSTRACT

Background: This study aims to evaluate the effect of sleep apnea (SA) on perioperative complications after total joint arthroplasty (TJA) and whether the type of anesthesia influences these complications.
Methods: Using the ninth and tenth revisions of the *International Classification of Diseases,* coding systems, we queried our institutional TJA database from January 2005 to June 2016 to identify patients with SA who underwent TJA. These patients were matched in a 1:3 ratio based on age, gender, type of surgery, and comorbidities to patients who underwent TJA but were not coded for SA. Perioperative complications were identified using the same coding systems. Multivariate analysis was used to test if SA is an independent predictor of perioperative complications and if type of anesthesia can affect these complications.
Results: A total of 1246 patients with SA were matched to 3738 patients without SA. Pulmonary complications occurred more frequently in patients with SA (1.7% vs 0.6%; $P < .001$), confirmed using multivariate analysis (odds ratio = 2.91; 95% confidence interval, 1.58-5.36; $P = .001$). Use of general anesthesia increased risk of all but central nervous system complications and mortality (odds ratio = 15.88; 95% confidence interval, 3.93-64.07; $P < .001$) regardless of SA status compared with regional anesthesia. Rates of pulmonary and gastrointestinal complications, acute anemia, and mortality were lower in SA patients when regional anesthesia was used ($P < .05$).
Conclusion: SA increases risk of postoperative pulmonary complications. The use of regional anesthesia may reduce risk of pulmonary complications and mortality in SA patients undergoing TJA.

Sleep apnea (SA) is a common breathing disorder that occurs as a result of partial or complete airway collapse during sleep. The prevalence of SA is rising and mild-to-severe disease is estimated to be present in 26% of the adult population [1]. As a result of rising prevalence and identification of new cases of SA, the proportion of patients with SA undergoing elective surgeries such as total joint arthroplasty (TJA) is expected to increase. A study by Berend et al [2] showed that 8.7% of TJA patients have an established diagnosis of SA. On the other hand, the prevalence of total hip arthroplasty (THA) and total knee arthroplasty (TKA) has been continually rising [3], and by 2030, it is estimated that the number of primary hip arthroplasty and primary knee arthroplasty will rise by 174% and 673%, respectively [4]. Keeping these projections in mind, the number of patients with SA who will require TJA is expected to rise, which necessitates physicians to be better prepared in dealing with the perioperative management of SA patients undergoing TJA.

Multiple studies have evaluated the effect of SA on perioperative complications in patients undergoing TJA; however, results

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of these studies are mixed, which makes it difficult to conclude the effect of SA on perioperative outcomes of TJA [5–7]. In addition, results of only a few of these studies have been adjusted for underlying comorbidities or type of anesthesia [7–9]. Given these limitations, the present study aims to evaluate the effect of SA on perioperative complications and mortality of patients undergoing TJA. We also evaluated whether the type of anesthesia (general vs regional) affects perioperative complications in SA patients.

Methods

The study protocol was reviewed and approved by the institutional review board. We reviewed our TJA database from January 2005 to June 2016 to identify patients with SA who underwent TJA using the *International Classification of Diseases, Ninth Revision, Clinical Modification* and the *International Classification of Diseases, Tenth Revision, Clinical Modification* (*ICD-9-CM* and *ICD-10-CM*) coding systems. For this purpose, we searched for those patients who had been coded for *ICD-9* procedure codes of 81.51 (THA) and 81.54 (TKA) and any *ICD-9-CM* codes of 786.03, 780.51, 780.53, 780.57, 327.20-327.27, or 327.29 for SA at the same time. Identified patients were matched in 1:3 ratio regarding age, gender, type of surgery, body mass index, and Charlson comorbidity index (CCI) with those patients who underwent TJA and were not coded for obstructive SA (OSA).

We used CCI to assess underlying comorbidities. The CCI consists of 17 items as follows: myocardial infarction, congestive heart failure, peripheral vascular disease, dementia, cerebrovascular accident, pulmonary disease, connective tissue disorder, peptic ulcer, mild-to-moderate liver disease, and diabetes (each item has a score of 1 point); hemiplegia, diabetes with complications, renal disease, and cancer (each item has a score of 2 points); severe liver disease and metastatic cancer (each item has a score of 3 points); and acquired immunodeficiency syndrome, which scores 6 points [10]. We queried our institutional database using the *ICD-9-CM* codes to identify these comorbidity items, which have previously been described [11]. Because we included age as an independent variable in the multivariate analysis, we did not adjust the CCI for age.

ICD-9-CM coding system was also used to identify perioperative complications. A broad list of pulmonary complications including pneumonia, pulmonary edema/insufficiency, respiratory arrest, pneumothorax, and pulmonary embolism were included as SA patients may be susceptible to postoperative pulmonary conditions. All the *ICD-9-CM* codes that were used to identify complications have been listed in Appendix 1. Other information including demographics, age, gender, ethnicity, body mass index, type of anesthesia (general vs regional), and length of hospital stay were also obtained for all study patients [11].

The controls were matched based on age, gender, type of surgery, and comorbidities in a 1:3 ratio. Univariate analysis was performed using the chi-square test (Fisher exact test where appropriate) for categorical data and the independent samples *t* test for numeric data. Logistic regression analysis was used to determine if presence of OSA and type of anesthesia are independent predictors of perioperative complications in the study population. Negative binomial analysis was used to compare total number of complications between the 2 groups and test if type of anesthesia can affect total number of complications. All analyses were performed using R 3.0.2 (The R Foundation for Statistical Computing, Vienna, Austria) using the "rms" package to perform the multivariate analysis. For all analyses, a P value <.05 were considered to be statistically significant.

Results

A total of 1246 patients with SA were identified who were matched in a 1:3 ratio with 3738 patients without SA as controls. Comparison of baseline characteristics of patients in these 2 groups has been shown in Table 1.

Univariate analysis demonstrated that pulmonary complications were the only complication that significantly occurred more frequently in patients with SA at (1.7% vs 0.6%; $P < .001$; Table 2). Logistic regression analysis adjusting for confounders showed that SA is an independent predictor for perioperative pulmonary complications (odds ratio = 2.91; 95% confidence interval [CI], 1.58-5.36; $P = .001$) but not other complications (Table 3). SA had on average 0.01 more overall complications than patients without SA; however, it was not statistically significant (95% CI, −0.026 to 0.050; $P = .61$). Length of hospital stay was longer in patients with OSA (2.71 vs 2.62 days; $P = .04$).

Using multivariate analysis adjusting for confounders, use of general anesthesia was associated with an increased risk for all perioperative complications except those of the central nervous system (Table 4). General anesthesia also increased risk for mortality compared with that of regional anesthesia (odds ratio = 15.88; 95% CI, 3.93-64.07; $P < .001$). Use of general anesthesia also increased total complication rate by 0.425, which was statistically significant (95% CI, 0.270-0.649; $P < .001$). Using univariate analysis, use of regional anesthesia in SA patients was associated with a lower rate of pulmonary and gastrointestinal complication, acute anemia, and mortality ($P < .5$) in SA patients (Table 5).

Discussion

The present rate and anticipated rise in the number of THA and TKA in the United States enforce the need to better identify risk factors of perioperative morbidity and mortality [3,4]. SA is highly prevalent in TJA patients, and given the potential negative effects of SA on outcome of surgical patients, the American Society of Anesthesiologists recommends physicians implement special considerations in perioperative care of SA patients [12]. It is believed that SA is a risk factor for perioperative cardiovascular complications and mortality in TJA patients; however, a recent systematic review showed that results of available studies are mixed, and it is not well-defined if type of anesthesia can affect rate of perioperative

Table 1
Comparison of Characteristics of 2 Groups of Patients Based on the Presence of Sleep Apnea.

Characteristics	No OSA	OSA	*P* Value
Number	3738	1246	
Gender (male), n (%)	2263 (60.5)	754 (60.6)	1
Age, y	63.49 (10.43)	63.18 (9.45)	.33
Body mass index, kg/m^2	33.65 (5.61)	34.05 (5.58)	.01
Charlson comorbidity index	0.19 (0.39)	0.20 (0.40)	.16
Number of patients had 2 joints replaced, n (%)	482 (12.9)	149 (11.9)	.40
Type of surgery, n (%)			1
Total hip arthroplasty	1692 (45.3)	564 (45.5)	
Total knee arthroplasty	2046 (54.7)	682 (54.5)	
Ethnicity, n (%)			.99
White	3033 (81.1)	1004 (80.6)	
African American	607 (16.2)	208 (16.7)	
Hispanic	34 (0.9)	12 (1.0)	
Asian	14 (0.4)	4 (0.3)	
Other/unknown, n (%)	50 (1.4)	18 (1.4)	
Type of anesthesia (general %)	199 (5.3)	85 (6.8)	.05

Numeric data have been expressed as mean (standard deviation).
OSA, obstructive sleep apnea.