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What is the Impact of Smoking on Revision Total Hip Arthroplasty?

Nicholas A. Bedard, MD, S. Blake Dowdle, MD, Jessell M. Owens, MD, Kyle R. Duchman, MD, Yubo Gao, PhD, John J. Callaghan, MD *

Department of Orthopaedics, University of Iowa, Iowa City, Iowa

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ABSTRACT

Background: There is a paucity of literature evaluating the impact of smoking on revision total hip arthroplasty (THA) outcomes. The purpose of this study was to identify the effect of smoking on complications after revision THA.

Methods: We queried the American College of Surgeons National Surgical Quality Improvement Program database to identify patients who underwent revision THA between 2006 and 2014. Patients were divided into current smokers and nonsmokers. Each cohort was compared in terms of demographics, preoperative comorbidities, and operative time. Multivariate logistic regression analysis was utilized. Adjusted odds ratios (OR) for the outcomes of any wound complication, deep infection, and reoperation within 30 days of revision THA were calculated.

Results: In total, 8237 patients had undergone a revision THA. Of these patients, 14.7% were current smokers and 85.3% were nonsmokers. Univariate analyses demonstrated that smokers had a higher rate of any wound complication (4.1% vs 3.0%, $P = .04$), deep infection (3.2% vs 1.9%, $P = .003$), and reoperation (6.8% vs 4.8%, $P = .003$). Multivariate analysis controlling for confounding demographic, comorbidity, and operative variables identified current smokers as having a significantly increased risk of deep infection (OR, 1.58; 95% CI, 1.04-2.38) and reoperation (OR, 1.37; 95% CI, 1.03-1.85).

Conclusion: Smoking significantly increases the risk of infection and reoperation after revision THA. The results are even more magnified for revision procedures compared to published effects of smoking on primary THA complications. Further research is needed regarding the impact of smoking cessation on mitigation of these observed risks.

As the volume of primary total hip arthroplasty (THA) rises in the United States, so does the burden of revision THA [1–3]. Epidemiologic studies estimate that in the year 2030, upward of 96,000 revision THA procedures will be performed [2,3]. Although revision THA has been shown to significantly improve patients' quality of life [4], the procedures are inherently fraught with higher complication rates relative to primary THA [5–7]. This growing number of revision THAs and associated high complication rate represent an increasing economic burden to the healthcare system [8]. As healthcare delivery transitions from a fee-for-service model to value-based healthcare initiatives like bundled payments, more attention is being paid to optimizing patients before surgery. Intervening upon modifiable risk factors allows surgeons to minimize complications, reduce costs, and improve outcomes.

One modifiable risk factor that has been identified in the primary total joint arthroplasty (TJA) literature is smoking. Smoking has been shown to substantially increase the risk of wound complications, infection, and revision following primary TJA [9–17]. However, there is a paucity of literature evaluating the impact of smoking on revision THA procedures. Given the increasing frequency of revision THA and the higher rate of complications that are associated with these procedures, it is important to understand the impact of modifiable risk factors on revision THA outcomes. Therefore, the purpose of this study is to evaluate the impact of smoking on 30-day complication rates following revision THA.

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* Reprint requests: John J. Callaghan, MD, Department of Orthopaedics, University of Iowa, 200 Hawkins Drive, Iowa City, Iowa 52242.

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Materials and Methods

The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database was queried to identify all patients who had revision THA between 2006 and 2014 using the Current Procedural Terminology codes 27134, 27137, and 27138. The ACS NSQIP database contains prospectively collected preoperative and 30-day postoperative morbidity and mortality data from 517 participating hospitals across the United States [18]. Data are collected on over 150 variables for patients undergoing major surgical procedures and recorded by each participating site's trained and certified surgical clinical reviewer. Internal auditing mechanisms are performed to ensure high-quality data and revealed an overall disagreement rate of approximately 2% [18,19].

Comorbidities, postoperative complications, and mortality data collected for the ACS NSQIP database have strict definitions for each variable and are collected for 30 days postoperatively. The complete list of definitions for each of these variables is provided within the ACS NSQIP data user guide [18]. Preoperative patient characteristics were obtained from the ACS NSQIP database and were divided into demographics, comorbidities, laboratory values, and operative variables. Individual preoperative patient characteristics can be found in Table 1. Patients met criteria as a "smoker" in the ACS NSQIP database if they reported smoking cigarettes in the year before their admission for surgery. All other patients were defined as a "nonsmoker" for this study. Only patients with operative wound class designated as clean at the time of revision THA were included in this study, and patients with clean-contaminated, contaminated, and dirty/infected wound class were excluded.

Thirty-day mortality and complication rates following revision THA were calculated for all patients using ACS NSQIP definitions for these variables and were categorized for statistical analysis. A composite category designated "any complication" included mortality, any wound complication, pneumonia, unplanned intubation, deep venous thrombosis, pulmonary embolism, renal insufficiency, acute renal failure, urinary tract infection, stroke, cardiac arrest, myocardial infarction, blood transfusion, sepsis, septic shock, and reoperation. Wound complications in ACS NSQIP database are categorized as superficial wound surgical site infection, deep wound surgical site infection, and organ space surgical site infection and surgical site wound dehiscence. As performed in previous studies, to best represent periprosthetic joint infection, the ACS NSQIP variables deep infection and organ space infection were combined into a single category "deep wound infection" [11]. Additionally, a composite category designation "any wound complication" included superficial wound infection, deep wound infection, organ space infection, and wound dehiscence.

Patients were categorized by smoking status and all preoperative patient characteristics were compared between cohorts (Table 1). Unadjusted complication rates were calculated for smokers and nonsmokers using chi-squared tests and models were created to adjust for confounding variables. Variables that were not charted for more than 80% of cohort were excluded from the multivariate analysis. The final multivariate model included all patient demographic, comorbidity, and operative variables that had univariate comparison P values < 0.1: age, race, body mass index, chronic obstructive pulmonary disease, corticosteroid use, bleeding disorder, preoperative blood transfusion, American Society of Anesthesiologists class, and operative time. Although operative time was not statistically different in the univariate analysis, it was included given previous literature that suggests prolonged operative time correlates with postoperative complications in primary TJA [20]. Multivariate logistic regression analysis was used to calculate adjusted odds ratios (OR) and 95% confidence intervals (CI) for the outcomes: any wound complication, deep infection, and reoperation. Categorical variables were compared using chi-square test, and continuous variables were compared using analysis of variance. Level of significance was $P < .05$ for all univariate and multivariate analyses. All statistical analyses were performed using SAS software (version 9.4, SAS Institute, Cary, NC).

Table 1
Patient Characteristics by Smoking Status.

	Smoker (N = 1208)	Nonsmoker (N = 7029)	P Value[b]
Demographics			
Age[a] (y)	56.9 ± 10.8	67.9 ± 12.3	<.0001
Female sex (%)	53.85	55.6	.25
Race (%)			<.0001
White	75.8	81.1	
Black	13.4	5.8	
Other	10.9	13.1	
Preoperative comorbidities			
BMI[a] (kg/m^2)	28.5 ± 8.1	28.9 ± 7.2	.08
Recent weight loss (%)	0.9	0.5	.08
Diabetes mellitus (%)	10.8	12.8	.05
Alcohol (%)	9.0	3.7	.002
COPD (%)	14.2	3.9	<.0001
Coronary artery disease (%)	0.4	0.7	.19
Peripheral vascular disease (%)	0	0.2	1
History of transient ischemic attack (%)	1.3	3.2	.30
Dialysis (%)	0.7	0.5	.27
Corticosteroid use (%)	4.1	5.5	.05
Bleeding disorder (%)	3.3	5.2	<.001
Preoperative blood transfusion (%)	0.5	1.1	.06
Radiation therapy (%)	0	0.2	1
Chemotherapy (%)	0.6	0.5	.57
Other recent operation (%)	1.9	1.9	1
Preoperative laboratory values[a]			
White blood cell count (10^3 cells/mL)	7.8 ± 2.4	7.01 ± 2.3	<.0001
Hematocrit (%)	39.8 ± 5.3	39.3 ± 4.9	<.01
Platelets (per mL)	260.4 ± 82.7	242.4 ± 73.9	<.0001
Creatinine (mg/dL)	0.9 ± 0.8	0.9 ± 0.5	.49
Serum albumin (g/dL)	3.9 ± 0.6	4.0 ± 0.5	.02
International normalized ratio	1.0 ± 0.2	1.1 ± 0.3	<.0001
Operative variables			
ASA classification			.04
1 (no disturbance)	1.5	2.3	
2 (mild disturbance)	40.4	43.4	
3 (severe disturbance)	54.1	50.1	
4 (life-threatening disturbance)	4.1	4.2	
Operative time			
Mean (standard deviation)	140.7 (73.18)	139.4 (72.96)	.554

BMI, body mass index; COPD, chronic obstructive pulmonary disease; ASA, American Society of Anesthesiologists; ANOVA, analysis of variance.

[a] Values are presented as the mean and the standard deviation. All other values written as percent of total patients.

[b] Calculated using ANOVA for continuous variables and chi-square tests for categorical variables.

Results

In total, 8237 patients underwent a revision THA procedure during the collection period and were included in this analysis. Of these patients, 14.7% were smokers and 85.3% were nonsmokers. Smokers were significantly younger than nonsmokers with an average age of 55.9 years at time of revision surgery compared to 67.9 years for nonsmokers ($P < .001$). There were no significant differences in gender distribution or body mass index between these cohorts but other comorbidity and demographic differences did exist (Table 1).

Univariate analysis demonstrated that smokers had significantly higher rates of any complication (11.4% vs 9.2%, $P = .01$), any wound complication (4.1% vs 3.0%, $P = .03$), deep wound infection (3.2% vs 1.9%, $P < .001$), and reoperation for any reason (6.8% vs 4.8%,