Comparison of Perioperative Adverse Outcomes Following Total Hip Arthroplasty In Patients with Diabetes: Insulin Dependence Makes a Difference

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Introduction

Diabetes mellitus (DM) is among the most common health conditions in the United States. It affects an estimated 34.1 million adults in the United States, with 1.5 million people diagnosed in 2015 alone.[1] Meanwhile, record numbers of patients are undergoing total hip arthroplasty (THA), and the number of patients undergoing THA is projected to continue to increase.[2] DM is also a known risk factor for osteoarthritis,[3] and some authors have suggested that all patients should be screened for DM prior to total joint arthroplasty.[4]

Previous studies have found that patients with DM are at increased risk for postoperative complications including mortality, stroke, urinary tract infections, pneumonia, nerve injury, surgical site infections, and revision surgery.[5-9] However, these studies do not distinguish between patients with Insulin Dependent Diabetes Mellitus (IDDM) and those with Non-Insulin Dependent DM (NIDDM). The aim of the current study was to use a large national, multi-institutional database to assess the correlation between insulin-dependent status and perioperative adverse outcomes after THA. Findings of these analyses have potential implications for preoperative risk stratification and quality improvement initiatives for these patient populations.

Methods

The 2005-2017 NSQIP database collected demographic information, intraoperative variables, and 30-day postoperative complications, and it followed patients after hospital discharge. Our institutional review board has granted exemption to studies using this database because all patient information in the NSQIP database is deidentified. Patients who underwent primary THA were identified using the Current Procedural Terminology (CPT) Code and International Classification of Disease (ICD) code. Comorbidity burden was summarized with a modified version of the Charleston Comorbidity Index (CCI) that has been adapted to the NSQIP database.[14,15]

In the NSQIP database, diabetes status is defined as one of three states. Patients have IDDM if they require daily insulin therapy, they have NIDDM if they use only non-insulin anti-diabetic agents, or patients are classified as not having diabetes if they either have no diabetes diagnosis or if their diabetes is controlled by diet alone. Patients who underwent THA were therefore divided into three groups based on diabetes status: No Diabetes, IDDM, or NIDDM.

All statistical analysis was completed using STATA 13 (StataCorp LP, College Station, TX). Chi-squared test was used to compare pre-operative demographics and comorbidities between the 3 groups (Table 1). Multivariate Poisson regression with robust error variance was then used to compare the relative risk of 30-day adverse outcomes. Multivariate regressions controlled for pre-operative characteristics that were found to be significantly different between groups. Because 17 outcomes were examined, Bonferroni's correction for multiple hypotheses was used. The corrected p-value was $P = 0.003$, and likewise 99.7% confidence intervals are reported.

Results

Based on inclusion and exclusion criteria, 151,027 patients were identified for the study. Of those who were identified, 4,501 had missing data and were excluded. This was less than 3% of the cohort. The final sample size was 146,526 patients. Of the total study population, 128,928 (88%) did not have diabetes, 13,647 (9%) had NIDDM, and 3,951 (3%) had IDDM. Table 1 presents the differences in demographics of these groups.

The relative risk of adverse events within 30 days of THA in patients with NIDDM compared to those without diabetes are shown in Table 2 and Figure 1. Based on multivariate analyses controlling for the variables in Table 1, patients with NIDDM were at significantly greater risk for 4 of the 17 adverse events reported in the database relative to patients without DM. The relative risk of adverse events within 30 days of THA in patients with IDDM compared to those with no diabetes are shown in Table 2 and Figure 2. In contrast to NIDDM, patients with IDDM were at greater risk of 12 of the 17 adverse events studied based similar multivariate analyses.

Overall, IDDM was associated with three times as many perioperative adverse events after THA

Table 1. Demographics of 146,526 patients who underwent Total Hip Arthroplasty, 2005-2017

	Without DM		NIDDM		IDDM		
Total	**128,928**		**13,647**		**3,951**		**p-value***
Age	Average: 65.3		Average : 67.5		Average: 66.9		<0.001
18-54	20,639	16.0%	1,232	9.0%	3,951	10 .6%	
55-64	39,389	30.6%	3,898	28.6%	1,147	29.0%	
65-74	41,704	32.4%	5,137	37.6%	1,500	38.0%	
75+	27,196	21.0%	3,380	24.8%	886	22.4%	
Sex							<.001
Female	72,224	56.1%	6,755	49.5%	1,857	47.0%	
Male	56,704	43.9%	6,892	50.5%	2,094	53.0%	
BMI	Average: 30.0		Average: 33.4		Average: 34.2		<.001
18-25	26,640	20.7%	1,052	7.7%	237	6.0%	
25-30	45,152	35.0%	3,382	24.8%	901	22.8%	
30-35	33,077	25.6%	4,186	30.7%	1,150	29.1%	
>35	24,059	18.7%	5,027	36.8%	1,663	42.1%	
CCI	Average: 3.14		Average: 3.37		Average: 3.35		<.001
0-2	37,642	29.2%	2,658	19.5%	831	21.0%	
3	43,864	34.1%	4,928	36.1%	1,426	36.1%	
>4	47,422	36.7%	6,061	44.4%	1,694	42.9%	
Functional Status Prior to Surgery							<.001
Independent	126,783	98.3%	13,330	97.7%	3,812	96.5%	
Dependent	2,145	1.7%	317	2.3%	139	3.5%	
Smoker							<.001
Yes	14,447	12.0%	1,562	11.5%	455	11.5%	
No	113,451	88.0%	12,085	88.5%	3,496	88.5%	

DM – Diabetes Mellitus, NIDDM – Non-Insulin Dependent Diabetes Mellitus, IDDM – Insulin Dependent Diabetes Mellitus, BMI – Body Mass Index, CCI – Charlson Comorbidity Index;

* Chi-squared tests were used to compare these variables (significance at $p < 0.05$), **Bolding** indicates statistical significance.

than NIDDM. Additionally, patients with IDDM had greater relative risks of adverse events than patients with NIDDM (sepsis or septic shock: RR = 2.35 versus 1.57, respectively, renal insufficiency: RR = 4.34 vs. 2.25, readmission: RR = 1.70 vs. 1.24, and extended LOS: RR = 1.87 vs. 1.29).

Discussion

As the prevalence of DM continues to increase, so does the importance of assessing its role in surgical outcomes and perioperative adverse events. Although previous studies have demonstrated that DM is associated with an increased rate of adverse events after THA, these studies did not distinguish between clinically identifiable subpopulations of patients with DM based on use of insulin in their treatment regimen.[16,17] Comparing the risks of adverse events after THA in these subpopulations could assist patients and providers in pre-operative patient preparation and optimization and post-operative planning and management.

The current study of a large cohort of patients with DM who underwent THA found that the need for insulin in the management of DM is a risk factor for greater relative risk and more perioperative adverse events than those not requiring insulin, independent of demographic characteristics and comorbidity burden. The results of this study are consistent with recent literature that shows that patients with IDDM are at a greater risk for many more adverse events than patients with NIDDM following total knee arthroplasty.[18]

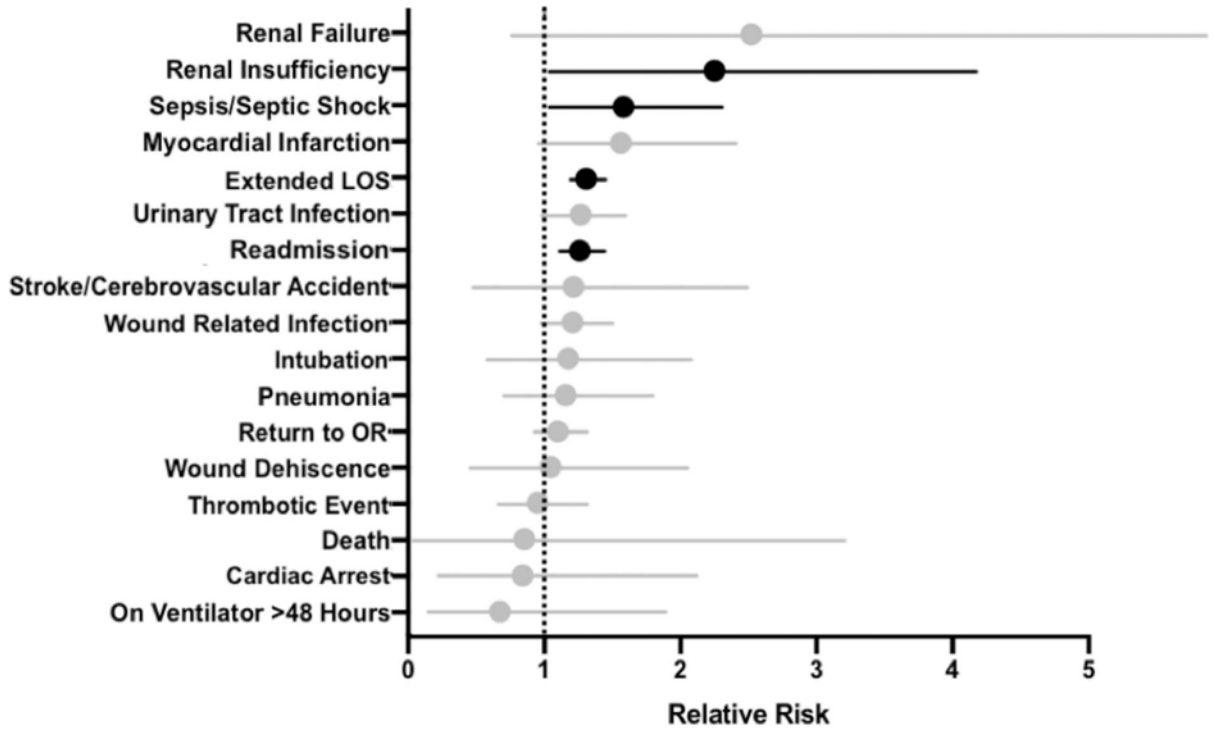
Compared to patients without diabetes, those with NIDDM were at increased perioperative risks of renal insufficiency, sepsis or septic shock, extended length of stay, or readmission with 30 days. Patients were IDDM were also at increased risk for these complications, but patients with IDDM were also at increased risk for renal failure, myocardial infarction, stroke or cerebrovascular accident, pneumonia, re-intubation, urinary tract infection, wound-related infection, or return to the operating room. Although both groups of diabetic patients were at increased risk for 4 of these 12 adverse events studied, compared to patients with NIDDM, the patients with IDDM were at greater relative risk for all 4 of these.

There were several limitations to the current study. One limitation relates to the method by which NSQIP defines patient populations with DM. DM was not classified as Type I or Type II, and measures of glycemic control such as hemoglobin A1c were not available. Additionally, THA specific outcomes and patient reported outcomes were not available for analysis, and the NSQIP database only followed patients for 30 days postoperatively. Finally, the mechanism of the association between the different DM categories and adverse events is not well defined or investigated using the available data.

Table 2. Relative Risk of adverse events within 30 days of THA in patients with NIDDM and IDDM vs those without DM

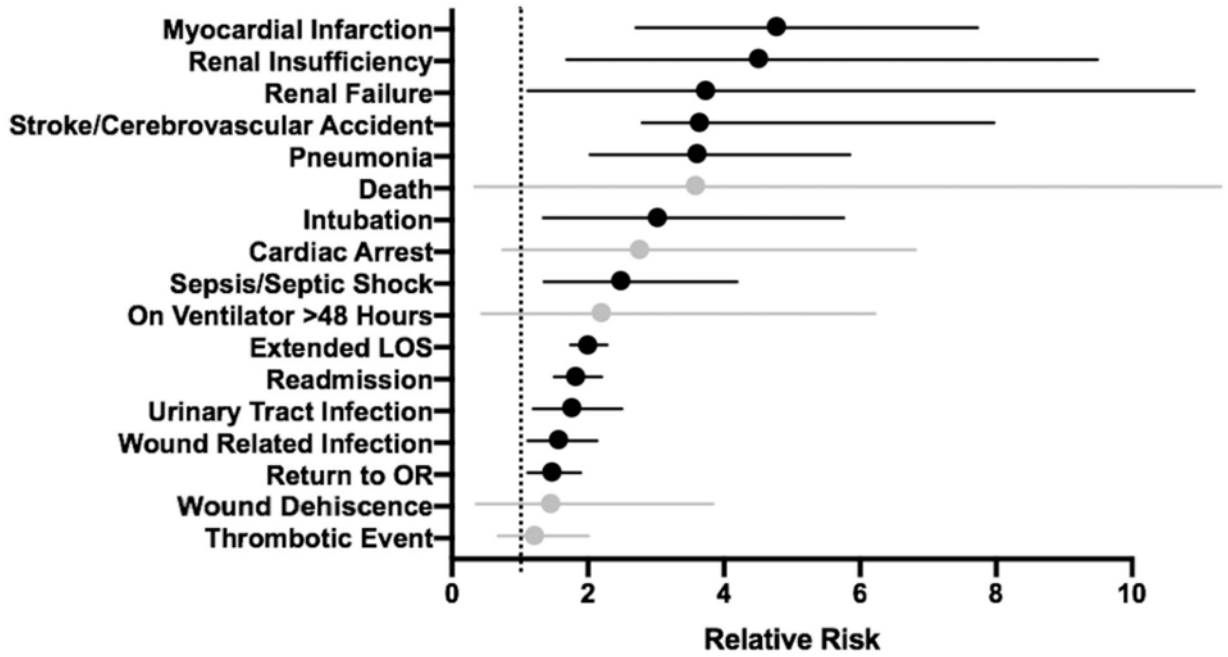
	Without DM	NIDDM				IDDM			
Total	**Percent**	**Percent**	**RR**	**CI**	**p-value**	**Percent**	**RR**	**CI**	**p-value**
	128,928		**13,647**				**3,951**		
Myocardial Infarction	0.19	0.36	1.55	0.93-2.40	0.005	0.99	4.59	2.56-7.48	< **0.001**
Renal Insufficiency	0.06	0.21	2.25	1.01-4.19	< **0.001**	0.43	4.34	1.56-9.21	< **0.001**
Renal Failure	0.03	0.11	2.52	0.73-5.91	0.004	0.18	3.57	1.00-10.6	**0.003**
Stroke/Cerebrovascular Accident	0.08	0.12	1.20	0.44-2.49	0.509	0.33	3.48	2.65-7.72	< **0.001**
Pneumonia	0.26	0.35	1.14	0.67-1.78	0.405	1.01	3.45	1.89-5.64	< **0.001**
Death	0.03	0.03	0.83	0.00-3.21	0.725	0.13	3.42	0.23-11.8	0.012
Intubation	0.13	0.20	1.16	0.55-2.07	0.495	0.51	2.87	1.22-5.55	< **0.001**
Cardiac Arrest	0.07	0.07	0.82	0.18-2.11	0.577	0.23	2.62	0.64-6.58	0.006
Sepsis/Septic Shock	0.25	0.51	1.57	1.01-2.30	**0.001**	0.81	2.35	1.23-4.01	< **0.001**
On Ventilator> 48 Hours	0.05	0.05	0.65	0.11-1.88	0.298	0.18	2.07	0.33-6.00	0.079
Extended Length of Stay (>3 days)	5.23	7.69	1.29	1.17-1.43	< **0.001**	11.1	1.87	1.61-2.14	< **0.001**
Readmission	2.94	4.30	1.24	1.09-1.42	< **0.001**	5.97	1.70	1.38-2.06	< **0.001**
Urinary Tract Infection	0.87	1.26	1.25	0.96-1.58	0.008	1.65	1.64	1.08-2.35	< **0.001**
Wound-Related Infection	0.98	1.58	1.19	0.95-1.48	0.018	2.02	1.45	1.00-1.99	**0.001**
Return to Operating Room	1.76	2.26	1.08	0.90-1.29	0.220	2.94	1.35	1.00-1.76	**0.002**
Wound Dehiscence	0.09	0.13	1.03	0.42-2.04	0.893	0.18	1.34	0.25-3.67	0.461
Thrombotic Event	0.54	0.59	0.93	0.63-1.29	0.562	0.71	1.10	0.57-1.87	0.628

THA – Total Hip Arthroplasty, NIDDM – Non-Insulin Dependent Diabetes Mellitus, IDDM – Insulin Dependent Diabetes Mellitus, DM – Diabetes Mellitus, RR – Relative Risk, CI – Confidence interval (95%), Poisson regression with robust error variance;
Bolding indicates statistical significance (significant at $p < 0.003$ after Bonferroni correction for multiple hypotheses)



THA – Total Hip Arthroplasty, DM – Diabetes Mellitus, LOS – Length of Stay, OR – Operating Room;
Error bars represent 95% confidence intervals and 2-sided alpha $p = 0.05$;
Bolding indicates statistical significance after correction for multiple adverse events ($p < 0.003$)

Figure 1. Relative risks of adverse events after THA in patients with non-insulin dependent diabetes mellitus vs patients without DM.



THA – Total Hip Arthroplasty, DM – Diabetes Mellitus, LOS – Length of Stay, OR – Operating Room;
Error bars represent 95% confidence intervals and 2-sided alpha p = 0.05;
Bolding indicates statistical significance after correction for multiple adverse events ($p < 0.003$)

Figure 2. Relative risks of adverse events after THA in patients with insulin dependent diabetes mellitus vs patients without DM

Conclusion

The results of the current study show that insulin dependence is an independent risk factor for adverse events following THA. Both NIDDM and IDDM are associated with adverse events after THA, but IDDM is associated with 3 times as many of the adverse events we studied. When both groups of diabetic patients are at increased risk for a given complication, the patients with insulin dependence were at greater risk. This information will be useful for providers for patient selection and management of post-operative expectations, and it may prove useful in mitigating the risks of some complications after surgery. Future studies should investigate the interaction between perioperative glycemic control, insulin use, and the risk of adverse events in patients with DM undergoing THA.

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