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Original research

Incidence, Risk Factors, and Subsequent Complications of Postoperative Hematomas Requiring Reoperation After Primary Total Hip Arthroplasty

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ABSTRACT

Background: Studies analyzing the incidence and clinical implications of postoperative hematomas after total hip arthroplasty (THA) remain limited. The purpose of the present study was to use the National Surgical Quality Improvement Program (NSQIP) dataset to determine rates, risk factors, and subsequent complications of postoperative hematomas requiring reoperation after primary THA.

Methods: Study population included patients who underwent primary THA (CPT code: 27130) from 2012-2016 recorded in NSQIP. Patients who developed a hematoma requiring reoperation in the 30-day postoperative period were identified. Multivariate regressions were created to identify patient characteristics, operative variables, and subsequent complications that were associated with a postoperative hematoma requiring reoperation.

Results: Among the 149,026 patients who underwent primary THA, 180 (0.12%) developed a postoperative hematoma requiring reoperation. Risk factors included body mass index (BMI) $\geq$ 35 (relative risk [RR]: 1.83, $P = .011$), American Society of Anesthesiologists (ASA) class $\geq$3 (RR: 2.11, $P < .001$), and history of bleeding disorder (RR: 2.71, $P < .001$). Associated intraoperative characteristics were an operative time $\geq$100 minutes (RR: 2.03, $P < .001$) and use of general anesthesia (RR: 1.41, $P = .028$). Patients developing a hematoma requiring reoperation were at higher risk of subsequent deep wound infection (RR: 21.57, $P < .001$), sepsis (RR: 4.3, $P = .012$), and pneumonia (RR: 3.69, $P = .023$).

Conclusions: Surgical evacuation for a postoperative hematoma was performed in about 1 in 833 cases of primary THA. Several nonmodifiable and modifiable risk factors were identified. Given the 21.6 times increased risk of subsequent deep wound infection, select, at-risk patients may benefit from closer monitoring for signs of infection.

Introduction

Primary total hip arthroplasty (THA) is one of the most commonly performed elective surgeries in the United States (U.S.) [1], with the demand for it in the U.S. expected to grow 71% by 2030 for a projected annual total of 635,000 cases [1]. With the increasing number of cases being performed, it is important to understand potential complications and implement strategies to mitigate risks.

A postoperative hematoma is a potential, albeit uncommon, complication after THA, with reported rates ranging from 0.41 to 1.7% [2,3]. One previous study found that 0.41% of patients required surgical intervention to treat postoperative hematoma after primary THA [3]. Although rare, this complication can be catastrophic, resulting in persistent wound drainage, excessive pain, neurological impairment, infection, and even death [2,4].

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There have been few studies assessing the risk factors for development of a postoperative hematoma after total joint arthroplasty. In the total knee arthroplasty population, bleeding disorders have been found to be associated with this complication [5]. In the THA population, Mortazavi et al. identified multiple risk factors including blood loss, administration of fresh frozen plasma and vitamin K, perioperative anticoagulation, and hormonal therapy [3]. However, the latter study collected data from a single institution, with a small sample size of 38 patients who developed a postoperative hematoma.

Larger studies investigating the incidence, risk factors, and clinical implications of postoperative hematomas requiring reoperation after primary THA remain limited. With increasing rates of THAs being performed as outpatient procedures [6], assessing risk factors for this complication may be helpful in protocol optimization.

This study used a large, national data set with 30-day postoperative data and over 100 procedural variables to identify patients who developed postoperative hematomas requiring reoperation after primary THA. Using the National Surgical Quality Improvement Program (NSQIP) database, the authors (1) calculated the incidence and timing of postoperative hematomas requiring surgical intervention after primary THA; (2) assessed associative factors for developing this complication; and (3) studied the relationship between postoperative hematomas requiring reoperation and outcomes after THA. We hypothesize that the overall incidence of postoperative hematomas is low and that patients with a postoperative hematoma would be at a significantly increased risk of subsequent infection.

Material and methods

Data source

The American College of Surgeons' NSQIP data set identifies information from more than 500 hospitals in the United States and internationally [7]. It includes more than 100 perioperative variables, and trained surgical reviewers record patient information through the 30th postoperative day. In the past decade, the NSQIP data set has been used to quantify risk factors in the field of arthroplasty and orthopaedics as a whole [7–9]. The institutional review board at the authors' institution granted an exemption for studies using NSQIP, as the data do not contain patient identifiers.

Patients who underwent primary THA were identified in NSQIP based on the Current Procedural Terminology code 27,130. Patients who had emergency surgery, nonelective surgery, or a primary International Classification of Diseases codes for trauma, tumor, or infection were excluded. In addition, patients who underwent bilateral THA procedures were excluded.

Patient preoperative and surgical characteristics

The following preoperative and surgical characteristics were extracted from NSQIP: age, gender, body mass index (BMI), preoperative functional status, smoking status, American Society of Anesthesiologists (ASA) classification, diabetes status, chronic steroid use, hypertension, dyspnea on exertion, chronic obstructive pulmonary disease, history of bleeding disorder, and operative time. A bleeding disorder was classified as any condition that increases the patient's risk of bleeding, such as vitamin K deficiency, hemophilia, thrombocytopenia, von Willebrand's disease, or chronic anticoagulation therapy that has not been discontinued before surgery.

Perioperative outcomes

Postoperative hematoma was identified under the variable termed "reason for reoperation". The number of days since primary THA that the complication occurred was recorded, as was the length of stay postoperatively after the index THA.

Statistical analyses

Statistical analyses were conducted in Stata version 13.1 (StataCorp, LP, College Station, TX). Level of significance was fixed at alpha <0.05. Multivariate Poisson regression with robust error variance was used to assess for an association between preoperative/surgical variables and incidence of postoperative hematomas requiring surgical evacuation. The final multivariate model was created using a backward stepwise method: All variables in Table 1 and Table 2 were initially included in the model, and variables with the highest P values were eliminated one-by-one until only variables with $P < .05$ remained. Variables remaining in the model denoted independent risk factors for development of a postoperative hematoma requiring reoperation.

Multivariate Poisson regressions with robust error variance were also used to check for any relationship between incidence of postoperative hematoma requiring surgical evacuation and subsequent occurrence of the following complications: pneumonia, deep wound infection, sepsis, reintubation, on ventilator for >48 hours, and death. All variables listed in Tables 1 and 2 were included in these regressions. Attributable complications were those that occurred after the postoperative hematoma, whereas non-attributable complications were those that occurred before the postoperative hematoma.

Approximately 1% of patients who met inclusion and exclusion criteria had an incomplete data set, and these patients were excluded from data analysis. Patients with specific missing variables including preoperative hematocrit, albumin, and international normalized ratio (missing for 4%, 49%, and 38%, respectively) were treated using the missing-indicator method [10]. Briefly, this method involves setting missing data elements to a predetermined value and adding a dummy variable (which represents whether the

Table 1
Patient characteristics.

Characteristic	Number	Percent
Total	149,026	100%
Developed a hematoma requiring reoperation		
No	148,846	99.88%
Yes	180	0.12%
Age (y, average: 64.9 ± 11.4)		
18-59	45,611	31%
60-69	51,341	34%
70-79	36,916	25%
≥80	15,158	10%
Gender		
Male	67,459	45%
Female	81,567	55%
Body mass index (kg/m^2, average: 30.3 ± 6.3)		
18-24	29,568	20%
25-29	49,749	33%
30-34	38,734	26%
≥35	30,975	21%
Functional status prior to surgery		
Independent	146,389	98%
Dependent	2637	2%
American Society of Anesthesiologists classification (ASA)		
1-2	86,126	58%
≥3	62,900	42%

Table 2
Additional patient characteristics.

Characteristic	Number	Percent
Total	149,026	100%
Current smoker within 1 y		
No	129,792	87%
Yes	19,234	13%
Preoperative anemia (hct <39% for males, hct <36% for females)		
No	124,151	83%
Yes	18,928	13%
Missing	5947	4%
Preoperative hypoalbuminemia (<3.5 mg/dL)		
No	72,515	49%
Yes	2902	2%
Missing	73,609	49%
Preoperative international normalized ratio (INR)		
≤1.2	88,189	59%
>1.2	4867	3%
Missing	55,970	38%
Diabetes mellitus		
No diabetes mellitus	131,281	88%
Non−insulin-dependent diabetes mellitus	13,667	9%
Insulin-dependent diabetes mellitus	4078	3%
Chronic steroid use		
No	143,483	96%
Yes	5543	4%
Hypertension		
No	65,877	44%
Yes	83,149	56%
Dyspnea on exertion		
No	142,322	96%
Yes	6704	4%
Chronic obstructive pulmonary disease		
No	143,207	96%
Yes	5819	4%
Bleeding disorder		
No	145,987	98%
Yes	3039	2%
Operative duration (min, average: 91.2 ± 38.0)		
0-74	53,628	36%
75-99	47,132	32%
≥100	48,128	32%
Anesthesia		
Other[a]	74,522	50%
General	74,504	50%

Hct, hematocrit; IV, intravenous; MAC, monitored anesthesia care.
[a] Includes epidural, MAC/IV sedation, regional, and spinal.

value for the variable is missing) to the multivariate model. As a result, the entire case entry can still be used in the analysis. This method has been previously used in studies using NSQIP [11].

Results

Incidence and timing of hematoma requiring reoperation

A total of 149,026 patients met the inclusion criteria, and of these, 180 (0.12%) developed a postoperative hematoma requiring reoperation. Patient demographics and comorbidity information are listed in Tables 1 and 2. Seventy-eight percent of these complications were diagnosed after hospital discharge from the index THA (Fig. 1).

Risk factors for hematoma requiring reoperation

Controlling for patient preoperative and surgical characteristics, the following independent risk factors for a postoperative hematoma requiring reoperation were determined: BMI ≥35 (relative risk [RR] = 1.83, 95% confidence interval [CI]: 1.13-2.98, $P = .011$), an ASA class ≥3 (RR: 2.11, 95% CI: 1.53-2.92, $P < .001$), a history of a bleeding disorder (RR: 2.71, 95% CI: 1.53-4.81, $P < .001$), an operative duration ≥100 minutes (RR: 2.03, 95% CI: 1.40-2.96, $P < .001$), and the use of general anesthesia (vs other types; RR: 1.41, 95% CI: 1.04-1.92, $P = .028$) (Table 3).

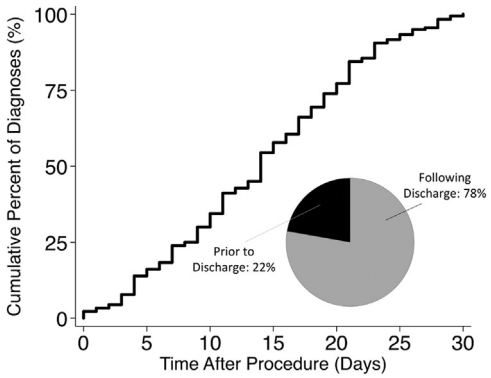

Figure 1. Timing of diagnoses. Percentages of postoperative hematomas requiring reoperation that occurred during the index hospitalization and after index hospitalization are represented.

Occurrence of a postoperative hematoma requiring reoperation was not independently associated with age, gender, smoking status, functional status before surgery, preoperative hypoalbuminemia, preoperative anemia, diabetes mellitus, chronic steroid use, dyspnea on exertion, hypertension, or chronic obstructive pulmonary disease.

Associated clinical complications

An analysis of clinical complications after the surgical evacuation of the hematoma was performed. After controlling for demographic and surgical variables, patients who had a surgery for a postoperative hematoma were more likely to develop the following

Table 3
Independent preoperative or procedural factors associated with development of postoperative hematoma requiring reoperation.

Characteristic	RR	95% CI	*P* value[a]
Body mass index (kg/m^2, average 30.4 ± 6.6)			**.011**
18-24	Ref.	-	
25-29	1.01	0.61-1.67	
30-34	1.38	0.84-2.25	
≥35	1.83	1.13-2.98	
American Society of Anesthesiologists classification (ASA)			**<.001**
1-2	Ref.	-	
≥3	2.11	1.53-2.92	
Bleeding disorder			**<.001**
No	Ref.	-	
Yes	2.71	1.53-4.81	
Operative duration (min, average: 91.2 ± 38.0)			**<.001**
0-74	Ref.	-	
75-99	1.40	0.93-2.11	
≥100	2.03	1.40-2.96	
Anesthesia			**.028**
Other[a]	Ref.	-	
General	1.41	1.04-1.92	

Ref., reference.
Bolding indicates statistical significance.
[a] Significant at $P < .05$.

Table 4
Subsequent postoperative complications associated with development of hematoma requiring reoperation.

Type of infection	Total cases	Cases of hematoma		RR	95% CI	*P* value[a,b]
	Number	Number	Percentage			
Deep wound infection						**<.001**
No	148,253	148	0.10%	Ref.	-	
Yes	773	32	4.14%	21.57	15.67-29.71	
Sepsis						**.012**
No	148,665	171	0.12%	Ref.	-	
Yes	361	3	0.83%	4.30	1.38-13.38	
Pneumonia						**.023**
No	148,574	177	0.12%	Ref.	-	
Yes	452	3	0.66%	3.69	1.20-11.35	
Death						.278
No	148,830	179	0.12%	Ref.	-	
Yes	196	1	0.51%	2.89	0.43-19.59	
Urinary tract infection						.506
No	147,731	175	0.12%	Ref.	-	
Yes	1295	1	0.08%	0.51	0.07-3.66	

Ref., reference.
Bolding indicates statistical significance.
[a] Significant at $P < .05$.
[b] Each multivariate regression included all demographic, comorbidity, and procedural characteristics in Table 1 to control for potential confounding.

subsequent complications: deep wound infection (RR: 21.57, 95% CI: 15.67-29.71, $P < .001$), sepsis (RR: 4.3, 95% CI: 1.38-13.38, $P = .012$), and pneumonia (RR: 3.69, 95% CI: 1.20-11.35, $P = .023$) (Table 4). After primary THA, patients who underwent surgery for a postoperative hematoma were not more likely to experience a urinary tract infection or death (Fig. 2).

Discussion

With the projected increase in demand for primary THA [1], it is important to further our understanding of potential associated complications and risk factor mitigation. In-depth studies of rare postoperative complications following THA, such as a postoperative hematoma, are limited in the orthopaedic literature. These studies may be useful in determining at-risk patients and facilitating protocol optimization.

A postoperative hematoma is a possible complication after THA [2,3]. Although uncommon, this complication can have substantial consequences, such as persistent wound drainage and infection [2,4]. Using NSQIP, our study aimed to identify the incidence, predictors, and the subsequent associated clinical complications of postoperative hematomas requiring reoperation after primary THA.

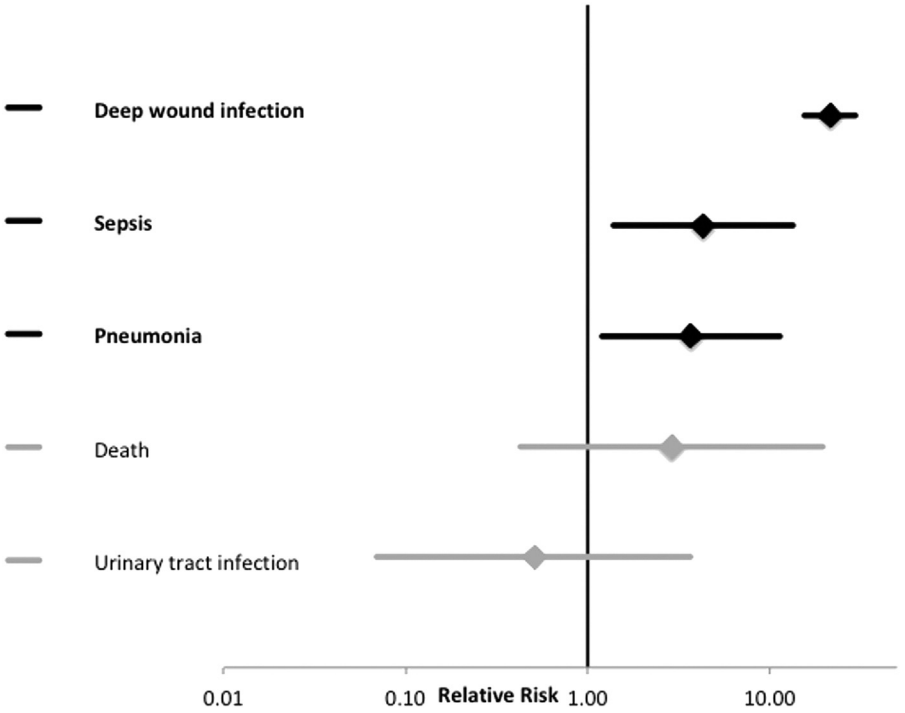

Figure 2. Depiction of adverse events listed at the left, and diamonds central to the horizontal lines indicate relative risks. Horizontal lines denote the 95% confidence intervals of those relative risks. Vertical line is defined as a relative risk (RR) of 1. Thus, horizontal lines that cross the vertical line specify relative risks that were not found to be statistically significant. Black lines and bolding specify relative risks that are statistically significant.

In our study, 180 of 149,026 (0.12%) total cases of primary THA developed a postoperative hematoma requiring reoperation. In the literature, rates of postoperative hematomas requiring reoperation range from 0.41% to 1.7% [2,3]. However, these referenced studies were limited by small sample size and stemmed from single institutions. The variability in the reported rates may also be due to differing preoperative comorbidity profiles. Furthermore, NSQIP only records data till the 30th postoperative day; therefore, postoperative hematomas requiring reoperation beyond the 30th postoperative day would not have been included in our analysis. This may also explain this discrepancy in rates.

We identified the following risk factors for the development of a postoperative hematoma requiring reoperation: BMI $\geq$35, ASA class $\geq$3, history of bleeding disorder, operative time $\geq$100 minutes, and the use of general anesthesia (vs other modalities of anesthesia). Of note, the association between wound dehiscence and BMI $\geq$35 has been previously studied [12–14]. Furthermore, our finding that a history of a bleeding disorder increases the risk of developing a postoperative hematoma requiring reoperation was similar to findings in the total knee arthroplasty population [5]. The association of general anesthesia with developing a hematoma requiring reoperation has not been previously reported in the literature.

After surgical hematoma evacuation following primary THA, patients carried a respective 21.6- and 4.3-times greater risk of a subsequent deep wound infection and sepsis. Consistent with our findings, Mortazavi et al. previously found that surgical hematoma evacuation was associated with numerous complications, 88% of which were infection-related [3]. A postoperative hematoma has been shown to increase local and systemic infection risk [15,16]. Our findings indicate that careful observation for wound infection or signs of systemic infection may be helpful in patients who undergo hematoma evacuation. There may also be a role for a course of extended oral antibiotics in this particularly high-risk population [17,18].

We also observed that postoperative hematoma requiring reoperation was associated with developing pneumonia (RR: 3.7). Prophylactic initiatives such as the use of an incentive spirometer, daily oral hygiene with chlorhexidine, head-of-bed elevation to at least 30 degrees, and having patients consume food sitting up can all help to significantly decrease pneumonia risk [19,20] and may be beneficial in this population.

There are strengths and weaknesses for this investigation. The strengths stem from the use of the NSQIP data set, an established, national database that pools data from over 500 participating institutions. NSQIP contains a large, heterogenous patient population of over 100 perioperative and patient variables. The large sample size across several years allows for assessment of patients with a wide variety of comorbidity profiles. As for weaknesses, we could not make comparisons between specific THA surgical techniques, determine the impact of tranexamic acid dosing regimens, or compare specific anticoagulation protocols, all of which may impact the risk of a patient developing a hematoma. Furthermore, there may also be errors in case coding that were unavoidable in this study. Choice and duration of anticoagulation regimen postoperatively are other variables important in the context of this paper; however, this information was not readily available in NSQIP.

Conclusions

The present study used NSQIP to find a reoperation rate for hematoma after primary THA of 0.12%, with increased risks of 21.6- and 4.3-times greater risk of a subsequent deep wound infection and sepsis for patients undergoing reoperation. Subsequent associated complications after postoperative hematoma formation were identified: deep wound infections, sepsis, and pneumonia. Given the catastrophic nature of a postoperative hematoma requiring reoperation, select at-risk patients may benefit from closer monitoring for signs of infection and consideration for use of an extended antibiotic prophylaxis regimen.

Conflicts of interest

L. E. Rubin is a paid consultant for DePuy Synthes and ConvaTec; receives royalties from SLACK, Inc. and Johns Hopkins University Press; is in the editorial or governing board of *Journal of Arthroplasty*, *Arthroplasty Today*, and *Reconstructive Review*; and is a board member of American Academy of Orthopaedic Surgeons. J. N. Grauer is in the editorial or governing board of *North American Spine Society Journal* and is a board member in *North American Spine Society Journal*, Lumbar Spine Research Society, and Cervical Spine Research Society. J. A. Bernstein is a paid consultant for DePuy Synthes, is a American Association of Hip and Knee Surgeons Young Arthroplasty Committee member, and is a American Academy of Orthopaedic Surgeons American Joint Replacement Registry Young Physician Committee member. M. Golden was a paid consultant for Iterum Pharmaceuticals. All other authors declare no potential conflicts of interest.

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