

Preoperative Corticosteroid Use for Medical Conditions is Associated with Increased Postoperative Infectious Complications and Readmissions After Total Hip Arthroplasty: A Propensity-Matched Study

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Corticosteroids are powerful anti-inflammatory steroid hormones that have many indications in the treatment of medical diseases, including advanced or poorly controlled asthma, chronic obstructive pulmonary disease (COPD), inflammatory bowel disease, allergic conditions, among other indications.¹⁻⁴ In orthopedics and rheumatology, systemic steroids are, at times, used in patients with rheumatoid arthritis, systemic lupus erythematosus, and vasculitides.⁵⁻⁷ Overman and colleagues,⁸ using data from the National Health and Nutrition Examination Survey between 1999 and 2008 identified both a 1.2% prevalence of chronic corticosteroid usage in the United States across all age groups and a positive correlation between steroid use prevalence and increasing age. In that study, nearly two-thirds of survey respondents reported using corticosteroids chronically for >90 days. Another observational study in the United Kingdom found that long-term steroid prescriptions increased between 1989 to 2008 and that 13.6% of patients with rheumatoid arthritis and 66.5% of patients with polymyalgia rheumatica or giant cell arteritis used long-term steroids.⁹

Enterally- or parenterally-administered corticosteroids have numerous systemic effects that are of particular relevance to orthopedic surgeons. Corticosteroids induce osteoporosis by preferentially inducing osteoclastic activity while inhibiting the differentiation of osteoblasts, ultimately leading to decreased bone quality and mass.¹⁰ As a consequence, patients who have previously used corticosteroids are more than twice as likely to have a hip

fracture.¹¹ Steroids also increase the risk of both osteonecrosis and myopathy, among other musculoskeletal effects.¹² In addition to orthopedic complications, steroids have broad inhibitory effects on both acquired and innate immunity, which significantly increases the risk of infections.¹³ This increased risk of infection is dose-dependent¹⁴ and synergistic with other immunosuppressive drugs.¹⁵

Patients with hip pain may receive localized corticosteroid hip joint injections during the nonoperative management of various hip pathologies, including arthritis, bursitis, and labral tears.^{16,17} Outcomes of patients who received intra-articular corticosteroid injections before total hip arthroplasty (THA) were evaluated in a systematic review of 9 studies by Pereira and colleagues.¹⁷ These authors found that the infection rate (both superficial and deep surgical site infections [SSI]) after THA in patients who received local steroid injection into the hip before surgery was between 0% and 30%.¹⁷ However, similar studies assessing the impact that systemic steroids have on outcomes after THA are lacking. Patients who undergo THA for conditions associated with higher lifetime steroid usage have worse outcomes than those who do not. For instance, in patients undergoing THA for rheumatoid arthritis, the rates of both postoperative periprosthetic joint infection and hip dislocation are higher, when compared with osteoarthritis.^{18,19} However, it is unclear how much of this difference in outcomes is due to the underlying disease, adverse effects of steroids, or both. Given the high prevalence of chronic systemic steroid use, it is essential to elucidate more clearly the impact that these medications have on perioperative outcomes after THA.

Therefore, the purpose of this study was to characterize short-term perioperative outcomes, including complication and readmission rates in patients undergoing THA while taking chronic preoperative corticosteroids. We also sought to identify the most common reasons for hospital readmission in patients who did and did not use long-term steroids.

Materials and Methods

Study Design and Setting

This investigation was a retrospective cohort study that utilized the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) registry.²⁰ The ACS-NSQIP is a prospectively collected, multi-institutional database that collects demographical information, operative variables, and both postoperative complications and hospital readmission data. Data is collected for up to 30 days after the index procedure, and patients are contacted by telephone if they are discharged before 30 days. Patient data is entered by specially trained surgical clinical reviewers and is routinely audited by the ACS-NSQIP, leading to more accurate data when compared with administrative research databases.^{21,22} The ACS-NSQIP has been used in orthopedic surgery outcomes-based studies.²³⁻²⁵

All patients undergoing THA between 2005 and 2015 were identified in the registry using primary Current Procedural Terminology code 27130. Patients were split into 2 groups based on whether or not they chronically used corticosteroids preoperatively for a medical condition. A patient was considered a chronic corticosteroid user if he/she used oral or parenteral corticosteroids within 30 days before the index procedure for >10 of the preceding 30 days. Those who received a 1-time steroid pulse or those who used topical or inhaled steroids were not considered as steroid users in this study.

Baseline Characteristics and Perioperative Outcomes

Baseline patient and operative characteristics, including patient age, gender, body mass index (BMI), functional

status, American Society of Anesthesiologists (ASA) class, anesthesia type, operative duration, and medical comorbidities including hypertension, COPD, diabetes mellitus, and smoking history, were compared between both groups. Perioperative outcomes that were assessed in this study include death, renal, respiratory, and cardiac complications, deep vein thrombosis or pulmonary embolism, stroke, sepsis, return to the operating room, urinary tract infection (UTI), wound dehiscence, superficial and deep SSI, need for a blood transfusion within 72 hours of index surgical procedure, and hospital readmissions. Renal complications were defined as acute or progressive renal insufficiency; respiratory complications were defined as failure to wean from the ventilator, need for intubation after the index procedure, and the occurrence of pneumonia; and cardiac complications were defined as myocardial infarction or cardiac arrest requiring cardiopulmonary resuscitation. Patients were excluded if they had missing baseline or operative characteristic data, an unclean wound classification at the time of admission, or if their THA was considered emergent.

Statistical Analysis

A propensity score-matched comparison was performed to adjust for differences in baseline and operative characteristics between the 2 cohorts in this study. In the current study, the propensity score was defined as the conditional probability that a patient chronically used preoperative corticosteroids for a medical condition, as a function of age, BMI, gender, ASA class, functional status, medical comorbidities, anesthesia type, and operative duration. A 1:1 matching with tight calipers (0.0001), and nearest-neighbor matching was used to generate 2 equally-sized, propensity-matched cohorts based on steroid status.²⁶ Nearest-neighbor matching identifies patients in both cohorts with the closest propensity scores for inclusion in propensity-matched cohorts. This matching is continued until 1 group runs out of patients to match. Baseline patient and operative characteristics for the unadjusted and propensity-matched groups were compared using Pearson's χ^2 analysis. Outcomes after THA by steroid status were also compared in both unadjusted and propensity-matched groups. Finally, all patients who were readmitted were identified, and the reason for readmission was determined using the International Classification of Disease Ninth (ICD-9) and Tenth (ICD-10) edition codes. Patients were classified as having an infectious readmission only if the ICD code clearly stated an infectious etiology. For instance, a patient with an intestinal infection due to *Clostridium difficile* (ICD-9 008.45) was counted as a gastrointestinal infection, whereas diarrhea without a distinctly specified etiology (ICD-9 787.91, ICD-10 R19.7) was counted as a gastrointestinal medical complication. Readmission data was only available in ACS-NSQIP from 2011 to 2015, constituting 92.5% of all patients included in this study. We used SPSS version 23 (IBM Corporation) for all statistical analyses, and defined a significant *P* value as $<.05$.

Results

Baseline Patient and Operative Characteristics

In total, we identified 101,532 patients who underwent THA (**Table 1**). Of these, 3714 (3.7%) chronically used corticosteroids preoperatively, whereas 97,818 (96.3%) did not.

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Table 2: Baseline Patient Characteristics of Patients Undergoing Total Hip Arthroplasty by Steroid Status

Number of patients	Unadjusted Cohorts			Propensity-Matched Cohorts		
	All Patients (112,332)	Yes (5,714)	No (106,618)	P-Value	Yes (5,714)	No (106,618)
Age*						
< 60	34.7%	36.6%	34.7%	0.658	36.2%	34.2%
60 - 70	37.6%	37.6%	37.6%	0.716	37.7%	37.7%
70 - 80	22.6%	22.6%	22.6%	0.716	22.7%	22.7%
> 80	5.6%	5.6%	5.6%	0.658	5.6%	5.6%
Female %	57.2%	60.7%	56.6%	<0.001 †	60.2%	56.6%
Body Mass Index (kg/m ²)						
< 30 (Non-obese)	67.6%	66.4%	67.7%	0.001 †	66.2%	67.2%
30 - 34.9 (Obese I)	26.6%	28.0%	26.5%	0.001 †	28.0%	26.5%
35 - 39.9 (Obese II)	10.6%	10.7%	10.6%	0.716	10.7%	10.6%
> 40 (Obese III)	5.7%	6.9%	5.2%	0.001 †	6.9%	5.2%
Comorbidities						
Hypertension	56.2%	69.6%	55.7%	<0.001 †	69.6%	55.7%
Diabetes Mellitus	13.2%	15.6%	13.1%	<0.001 †	15.6%	13.1%
COPD	4.8%	6.6%	4.6%	<0.001 †	6.6%	4.6%
Smoking Status	13.4%	16.7%	13.0%	0.001 †	16.7%	13.0%
Dependent Functional Status	2.6%	5.7%	2.0%	<0.001 †	5.7%	2.0%
ASA Class						
I or II	56.7%	55.0%	56.7%	0.001 †	55.0%	56.7%
III	38.6%	43.0%	38.5%	0.001 †	43.0%	38.5%
IV	1.8%	3.0%	1.7%	<0.001 †	3.0%	1.7%
Anesthesia Type						
General	54.4%	57.6%	54.3%	0.001 †	57.6%	54.3%
Regional	45.6%	42.3%	45.7%	0.001 †	42.3%	45.7%
Operative Duration (minutes)						
< 150	54.7%	52.7%	54.8%	0.001 †	52.7%	54.8%
150 - 180	42.2%	45.6%	42.1%	0.001 †	45.6%	42.1%
> 180	3.1%	1.7%	3.1%	0.001 †	1.7%	3.1%

*All American Society of Anesthesiologists (ASA) Class Operative Patients (OSAP) Scores

† Significant p-values are defined as < 0.05, and are presented in bold and highlighted

When the unadjusted cohorts were compared, patients using corticosteroids were more likely to be female, less likely to obese, more likely to have hypertension, diabetes mellitus, COPD, higher ASA class, undergone THA with general anesthesia, and have a dependent functional status ($P < .001$ for all comparisons). After propensity matching, 2 equally sized cohorts of 3618 patients each were generated based on steroid status and no differences in baseline and operative characteristics were identified between the 2 groups.

Clinical Outcomes by Steroid Status

A comparison of unadjusted cohorts showed that patients who used preoperative steroids had an increased rate of any complication (7.89%) when compared with those who did not (4.87%) (**Table 2**).

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Table 3: Bivariate Comparison of Adverse Outcomes in Unadjusted Cohorts by Steroid Status

	Unadjusted Cohorts		P-value
	Yes (5,714)	No (106,618)	
Any complication	7.89%	4.87%	< 0.001 †
Death	0.34%	0.37%	0.263
Cardiac complications	0.12%	0.13%	0.264
Renal complications	0.35%	0.19%	0.001 †
Respiratory complications	1.27%	0.57%	< 0.001 †
Deep vein thromboses/Pulmonary embolism	0.16%	0.13%	0.050
Stroke	0.04%	0.04%	0.168
Return to operating room	3.09%	2.01%	< 0.001 †
Sepsis	0.83%	0.28%	< 0.001 †
Urinary tract infection	1.72%	1.06%	< 0.001 †
Wound dehiscence	0.27%	0.13%	0.071
Deep surgical site infection	0.67%	0.29%	< 0.001 †
Superficial surgical site infection	1.02%	0.68%	0.012 †
Blood Transfusion	15.04%	11.04%	< 0.001 †
Readmission (30 days)	4.52%	3.02%	< 0.001 †

† Significant p-values are defined as < 0.05, and are presented in bold and highlighted

Similarly, those who used corticosteroids preoperatively had an increased rate of renal complications, respiratory complications, return to the operating room, sepsis, UTI, superficial and deep SSI, and perioperative blood transfusions. They also were more likely to have a 30-day hospital readmission ($P < .05$ for all comparisons).

When propensity-matched cohorts were compared, patients who used steroids preoperatively were found to have higher rates of any complication (odds Ratio [OR] 1.30, $P = .003$), sepsis (OR 2.07, $P = .022$), UTI (OR 1.61, $P = .020$), superficial SSI (OR 1.73, $P = .038$), and hospital readmission (OR 1.50, $P < .001$; **Table 3**).

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Table III: Bivariate Comparison of Adverse Outcomes in Prospectively-Matched Cohorts by Steroid Status

	Steroid Usage		Odds Ratio	P-value
	Yes	No		
Any complication	3.71%	3.80%	1.34	0.803 †
Death	0.19%	0.10%	1.00	0.999
Cardiac complications	0.19%	0.30%	0.64	0.340
Renal complications	0.30%	0.39%	1.07	0.540
Respiratory complications	0.29%	0.80%	1.39	0.161
Deep vein thrombosis/pulmonary embolism	0.77%	0.75%	1.04	0.892
Stroke	0.07%	0.00%	0.50	0.564
Return to operating room	2.80%	2.87%	1.04	0.781
Sepsis	0.80%	0.90%	1.07	0.822 †
Urinary tract infection	1.89%	1.80%	1.01	0.828 †
Wound dehiscence	0.19%	0.09%	2.13	0.206
Deep surgical site infection	0.44%	0.33%	1.42	0.662
Superficial surgical site infection	1.89%	0.40%	1.73	0.088 †
Blood Transfusion	13.13%	13.94%	1.09	0.112
Readmission (30 day)	3.86%	3.90%	1.00	0.862 †

† Significant p-values are defined as < 0.05, and are presented in bold and highlighted.

Reasons for Hospital Readmission

In total, 3397 patients were readmitted to the hospital within thirty days. Of these, 226 used steroids preoperatively, and 3171 did not (Table 4).

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Table IV: Reasons for Hospital Readmission after Total Hip Arthroplasty by Steroid Status

Number of Patients Readmitted within 30 days	Number of patients	All Patients	% Readmitted	Preoperative Steroid Use			
				Yes		No	
				Number of patients	% Readmitted	Number of patients	% Readmitted
		93,393		3,466		89,927	
		3,397		226	100%	3,171	100.0%
Infectious Complications	864	25.4%	72	31.9%	792	25.0%	
Surgical site infection	539	15.9%	32	14.2%	507	16.0%	
Respiratory Infection	90	2.6%	13	5.8%	77	2.4%	
Genitourinary infection	51	1.5%	3	1.3%	48	1.5%	
Sepsis	51	1.5%	6	2.7%	45	1.4%	
Cellulitis	51	1.5%	9	4.0%	42	1.3%	
Periprosthetic joint infection	30	0.9%	4	1.8%	26	0.8%	
Fever	25	0.7%	3	1.3%	22	0.7%	
GI Infection	16	0.5%	--	--	16	0.5%	
Other infection	11	0.3%	2	0.9%	9	0.3%	
Hip-Related Complications	811	23.9%	48	21.2%	763	24.1%	
Problem with prosthesis	260	7.7%	16	7.1%	244	7.7%	
Hemorrhage	157	4.6%	13	5.8%	144	4.5%	
Periprosthetic fracture	111	3.3%	5	2.2%	106	3.3%	
Femoral or hip fracture	104	3.1%	4	1.8%	100	3.2%	
Pain	57	1.7%	4	1.8%	53	1.7%	
Wound complication	55	1.6%	4	1.8%	51	1.6%	
Hip dislocation	44	1.3%	--	--	44	1.4%	
Hip or thigh sprain, strain, or contusion	16	0.5%	1	0.4%	15	0.5%	
Joint effusion, seroma, or hemarthrosis	7	0.2%	1	0.4%	6	0.2%	
Medical Complications	991	29.2%	59	26.1%	932	29.4%	
Gastrointestinal	256	7.5%	13	5.8%	243	7.7%	
Cardiovascular	184	5.4%	13	5.8%	171	5.4%	
Deep vein thrombosis and/or pulmonary embolism	158	4.7%	8	3.5%	150	4.7%	
Neuropsychiatric	96	2.8%	6	2.7%	90	2.8%	
Other musculoskeletal	54	1.6%	1	0.4%	53	1.7%	
Genitourinary	51	1.5%	7	3.1%	44	1.4%	
Respiratory	48	1.4%	1	0.4%	47	1.5%	
Other	38	1.1%	--	--	38	1.2%	
Electrolyte or fluid abnormality	35	1.0%	3	1.3%	32	1.0%	
Hematological	24	0.7%	0	0.0%	24	0.8%	
Medication or substance overdose or withdrawal	17	0.5%	2	0.9%	15	0.5%	
Dermatological	16	0.5%	3	1.3%	13	0.4%	
Endocrine	9	0.3%	2	0.9%	7	0.2%	
Cancer	5	0.1%	--	--	5	0.2%	
Unknown reason	732	21.5%	47	20.8%	684	21.6%	

Readmission data is only available from 2011 to 2015, which includes 92.5% of all patients included in this study

The most common reason for hospital readmission in patients who used preoperative corticosteroids was infectious complications (72 patients, 31.9% of all readmitted patients in this cohort), followed by medical complications (59 patients, 26.1%), and hip-related complications (48 patients, 21.2%). In those who did not use steroids preoperatively, the most common reason for hospital readmission was medical complications (932

patients, 29.4% of all readmitted patients in this cohort), followed by infectious complications (792 patients, 25.0%), and hip-related complications (763 patients, 24.1%).

Discussion

Nearly 3% of individuals >80 years in the US population chronically use corticosteroids for a medical condition,⁸ and this rate is likely higher in specific subsets of patients, such as those with rheumatoid arthritis.⁹ While some studies have assessed the impact of intra-articular corticosteroid hip injections on perioperative outcomes in THA,¹⁷ similar studies assessing systemic corticosteroid usage are lacking. The purpose of this study was to characterize short-term perioperative outcomes in patients undergoing THA who chronically use systemic steroids when compared with those who do not. We found that the prevalence of preoperative chronic steroid use in this cohort of THA patients was 3.7%. We also identified increased rates of infectious complications, including sepsis, UTI, and superficial SSI, in patients who used preoperative corticosteroids. Furthermore, we found an increased rate of hospital readmissions in corticosteroid users and identified the most common reason for hospital readmission as infectious complications in this cohort.

The primary finding of this study was an increase in postoperative infections in patients who use preoperative steroids chronically for medical conditions. Immunosuppression has previously been identified as a risk factor for developing periprosthetic joint infections. Tannenbaum and colleagues²⁷ performed a retrospective study of 19 patients who underwent either a kidney or liver transplant and were maintained on an induction regimen of either prednisone and azathioprine or cyclosporine. These 19 patients also underwent either a THA or total knee arthroplasty, and 5 of these patients (26.3%) developed a periprosthetic joint infection after an average of 3.4 years following the arthroplasty procedure. In another study of 37 renal transplant and dialysis patients who underwent a total of 45 THA procedures, there were 3 instances of superficial SSI and 2 instances of deep SSI.²⁸ However, reported infection rates in transplant patients undergoing THA vary significantly, and studies have been unable to assess the true impact that chronic immunosuppression has on perioperative infection rates.²⁹ In this study, patients who used preoperative corticosteroids chronically were at increased risk of perioperative infections, including sepsis, UTI, and superficial SSI.

Deep vein thrombosis is another postoperative complication that has been associated with chronic steroid use.³⁰ In a case-control study of 38,765 patients who developed a venous thromboembolism and 387,650 control patients who did not, Johannesdottir and colleagues³⁰ found an increased thromboembolic risk in current users of systemic glucocorticoids, but not former users, as well as an increased risk as the dose of glucocorticoids increased. We were not able to identify a similar increase in DVT/PE in chronic corticosteroid users, perhaps due to our sample size, or because we could not do subgroup analyses based on the type or dosage of steroid that a patient was taking. Future studies that identify the highest risk patients among those using systemic corticosteroids are important because parenteral corticosteroids are being increasingly used in THA to alleviate postoperative pain as an opioid-sparing measure.^{31,32}

Finally, we also found that patients who use chronic, systemic corticosteroids are at an increased risk for hospital readmission, when compared with those patients who are not using steroids and are most likely to be readmitted for an infectious complication. Schairer and colleagues³³ assessed readmission rates after THA and found 30- and 90-day readmission rate of 4% and 7%, respectively. These authors also found that medical complications accounted for approximately 25% of readmissions, and hip-related complications (eg, dislocation, SSI) accounted for >50%. In our study, we found a 30-day readmission rate in non-steroid users of 3.53% and a rate of 6.52% in chronic steroid users. More than 30% of patients using a steroid were readmitted for infectious complications. As THA is becoming increasingly reimbursed under a bundled payments model by Medicare and Medicaid,³⁴⁻³⁶

reducing short-term readmissions is imperative. Therefore, discharge counseling that emphasizes how to recognize both the signs and symptoms of infection as well as how to prevent infections, such as reducing SSIs through appropriate wound care, may be warranted in higher risk chronic steroid users.

This study has a number of limitations that are inherent to ACS-NSQIP. First, we lacked specific information on a patient's steroid history, including which corticosteroid they were using, dosage, frequency, and the indication for corticosteroid therapy. Therefore, we were unable to establish a dose-dependent relationship between steroid exposure and postoperative complications after THA. Second, we were able to assess only 30-day rates of complications and readmissions, and therefore, we were unable to identify intermediate- and long-term effects of systemic corticosteroid use on THA. Finally, we could not determine orthopedic- or hip-specific postoperative outcomes, such as functional scores and range of motion.

Conclusion

In conclusion, this study quantified the increased risk for perioperative complications and hospital readmissions in patients who chronically use corticosteroids and are undergoing THA, when compared with those who do not use corticosteroids. These results suggest that patients who are on long-term steroids are at an increased risk for complications, primarily infectious complications. This finding has important implications for patient counseling, preoperative risk stratification, and suggests that higher risk patients, such as chronic steroid users, may benefit from improved discharge care to decrease complication rates.

Key Info

Key Info:

Take-Home Points

- The rate of preoperative corticosteroid usage is low (3.7%).
- Patients using preoperative corticosteroids had increased rates of total 30-day complications.
- Adverse outcomes that are increased include infectious complications (eg, sepsis, urinary tract infection, surgical site infection).
- Hospital readmissions are also increased in patients taking preoperative corticosteroids, with the most common reason being infection.
- Increased postoperative counseling and surveillance may be warranted in this patient population.

Figures/Tables

Figures / Tables:

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