Research Article

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Chronic Corticosteroid Use as a Risk Factor for Perioperative Complications in Patients Undergoing Total Joint Arthroplasty

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Abstract

Background: Osteoarthritis may be caused by or concurrent with diseases such as rheumatoid arthritis or systemic lupus erythematosus, which rely on chronic corticosteroids regimens for treatment. If a total knee or hip arthroplasty is needed, this chronic treatment method has been associated with poorer surgical outcomes.

Methods: A retrospective analysis of data collected by the American College of Surgeons National Surgical Quality Improvement Program was conducted. The Current Procedural Terminology codes were used to identify 403,566 total knee arthroplasty and total hip arthroplasty patients who were then stratified by the use of chronic corticosteroids for univariate analysis.

Results: Forteen thousand seven hundred seventy-four of the patients identified were prescribed chronic corticosteroid regimens. A statistically significant difference was observed in perioperative complications for patients prescribed with corticosteroids, including higher rates of surgical site infection ($P = 0.0001$), occurrence of deep incisional surgical site infection ($P < 0.0001$), occurrences of organ space surgical site infection ($P < 0.0001$), wound dehiscence ($P < 0.0001$), general would infection ($P < 0.0001$), pneumonia ($P < 0.0001$), occurrences of unplanned intubation ($P = 0.0002$), urinary tract infection ($P < 0.0001$), and readmission ($P < 0.0001$). No statistically significant difference was observed in the 30-day mortality between the 2 groups (0.63), venous thromboembolic event (0.42), cerebrovascular accident (0.12), myocardial infarction (0.49), cardiac arrest (0.098), deep vein thrombosis (0.17), or sepsis (0.52).

Conclusion: Many of the notable differences in complications may be directly attributed to the immunosuppressive nature of corticosteroids. With increased knowledge of which perioperative complications to monitor, surgeons can tailor treatment strategies to this population that reduce morbidity and improve outcomes.

Total joint arthroplasty (TJA) is a procedure frequently performed for the treatment of end-stage joint osteoarthritis. The combined incidence of primary total knee arthroplasty (TKA) and total hip arthroplasty (THA) in the United States in 2010 was greater than 1 million, with a further 100,000 cases of revision knee and hip arthroplasties; this number is projected to increase with the aging population.[1-3] Furthermore, it is estimated that the prevalence of corticosteroid use in the United States is nearly 1.2%.[4] A number of patients presenting for TJA, such as those with rheumatoid arthritis, have comorbidities that are managed with chronic corticosteroid use resulting in notable overlap between these patient populations.[5,6]

Corticosteroids are used for chronic management of immune and inflammatory processes, but the same mechanisms that facilitate their anti-inflammatory and immunosuppressive effects also cause delayed wound healing.[7,8] Specifically, corticosteroids decrease the ability of immune cells to infiltrate wounds via downregulation of cytokines and adhesion proteins in the endothelium (intracellular adhesion molecule [ICAM]), decrease fibroblast proliferation, and decrease the ability to perform collagen remodeling.[7,9] These mechanisms are believed to contribute to the clinical finding that chronic corticosteroids result in poorer outcomes of surgical procedures, including TJAs.[5,6,8,10-13] Associated complications include an increased need for revision arthroplasty, increased risk of readmission, thromboembolism, mortality, urinary tract infection (UTI), and deep and superficial wound infections.[6,8,10-13]

Few studies have examined the independent risk factor of chronic corticosteroid use for perioperative complications after THA and TKA,[12,13] and none have examined a broad range of complications. Therefore, this study aims to determine if chronic corticosteroid utilization is associated with an increase in perioperative complications in THA, TKA, and revision knee and hip arthroplasty.

Methods

This was a retrospective analysis of prospectively collected data from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database between 2010 and 2017. The ACS-NSQIP is a national database of 30-day postoperative morbidity and mortality outcomes from more than 500 institutions in the United States. The database includes more than 300 variables including preoperative, intraoperative, and postoperative variables. Because the ACS-NSQIP is a Health Insurance Portability and Accountability Act (HIPPA) compliant deidentified database, this study was exempt from Institutional Review Board (IRB) approval.

Patients who underwent TJA, including primary TKA, primary THA, revision TKA, and, revision THA, were identified using the following Current Procedural Terminology codes: 27447, 27130, 27134, 27137, 27138, 27486, and 27487. A total of 403,566 patients met the Current Procedural Terminology code search criteria, and none were excluded.

Patient characteristics included patient demographics, medical comorbidities, preoperative condition, and surgical variables. Patient demographics included sex and age. Medical comorbidities included obesity (body mass index > 30), diabetes, current smoker within one year, pulmonary comorbidities (ventilator dependence within 48 hours before surgery or a history of chronic obstructive pulmonary disease), cardiac comorbidities (hypertension requiring medication or a history of congestive heart failure), renal comorbidities (history of acute renal failure or progressive renal insufficiency), currently requiring or on dialysis, and bleeding disorders. Preoperative conditions included American Society of Anesthesiologists (ASA) class ≥3, dyspnea at rest, poor functional status, weight loss, and patients who received preoperative transfusion of ≥1 unit of whole/packed red blood cells (RBC) in 72 hours before surgery.

The primary outcome measures for this study included mortality and perioperative complications occurring within 30 days after surgery. The perioperative complications reviewed were wound infection and complications, including surgical site infection, occurrence of deep incisional surgical site infection, occurrences of organ space surgical site infection, and wound dehiscence. Also included were pneumonia, occurrences of unplanned intubation, episode of venous thromboembolic event, failure to wean from the ventilator within 48 hours after surgery, UTI, postoperative cerebrovascular accident, cardiac arrest, myocardial infarction, deep vein thrombosis (DVT), sepsis, and readmission.

Univariate statistical analysis was performed on baseline characteristics and for mortality and perioperative complication measures. Statistical significance was set at $P = 0.05$. All statistical analysis were performed using the SAS University Edition using SAS Studio 3.8.

Results

In our cohort of 403,566 patients, 3.7% (14,774 of 403,566) were prescribed corticosteroids for a chronic medical condition. Some baseline patient characteristics were significantly different between patients who were prescribed corticosteroids and those who were not (Table 1). Statistically significant differences in medical comorbidities included obesity

Table 1

Baseline Patient Characteristics in the Patients Prescribed Corticosteroids for a Chronic Condition and No Corticosteroid Use Groups, Including Medical Comorbidities at the Time of Surgery, Preoperative Condition, and Operative Variables

	No Steroid Use (n = 388,792)		Steroid Use (n = 14,774)		
Patient Characteristics	**n**	**%**	**n**	**%**	***P* Value**
Sex					
Male	159,882	41.12	4,808	32.54	
Female	228,728	58.83	9,962	67.43	
Age > 65	207,263	53.31	7,357	49.80	
Medical comorbidities					
Obesity	220,208	56.64	7,709	52.18	<0.0001
Diabetes	61,778	15.89	2,334	15.80	0.7647
Smoking	40,045	10.30	1,562	10.57	0.2845
Pulmonary comorbidities	13,894	3.57	1,231	8.33	<0.0001
Cardiac comorbidities	239,939	61.71	9,438	63.88	<0.0001
Renal comorbidities	577	0.15	36	0.24	0.0035
Dialysis Dependent	675	0.17	75	0.51	<0.0001
Bleeding disorder	8,414	2.16	586	3.97	<0.0001
Preoperative condition					
ASA class > 3	6,695	1.72	621	4.20	<0.0001
Dyspnea at rest	695	0.180	85	0.58	<0.0001
Poor functional status	6,067	1.56	474	3.21	<0.0001
Weight loss	565	0.15	53	0.36	<0.0001
Transfusion	22,521	5.79	1,233	8.35	<0.0001
Surgical variables					
Primary TKA	225,103	57.90	8,208	55.56	
Primary THA	140,374	36.11	5,337	36.12	
rTKA	12,989	3.34	608	4.12	
rTHA	10,326	2.66	621	4.20	

ASA = American Society of Anesthesiologists, rTHA = revision total hip arthroplasty, rTKA = revision total knee arthroplasty, THA = total hip arthroplasty, TKA = total knee arthroplasty

($P < 0.0001$), pulmonary comorbidity ($P < 0.0001$), cardiac comorbidity ($P < 0.0001$), renal comorbidity ($P = 0.0035$), patients on dialysis ($P < 0.0001$), and bleeding disorder ($P < 0.0001$). Regarding preoperative patient characteristics, ASA class ($P < 0.0001$), dyspnea at rest ($P < 0.0001$), poor functional status ($P < 0.0001$), weight loss ($P < 0.0001$), and preoperative transfusion of ≥1 unit of whole/packed RBCs in 72 hours before surgery ($P < 0.0001$) all were significantly different between the chronic corticosteroid and control groups.

The results of the univariate analysis are summarized in Table 2. No statistically significant difference was observed in the 30-day mortality between the two groups. However, a statistically significant difference was observed in perioperative complications for patients prescribed corticosteroids, including higher rates of surgical site infection ($P < 0.0001$), occurrence of deep incisional surgical site infection ($P < 0.0001$), occurrences of organ space surgical site infection ($P < 0.0001$), wound dehiscence ($P < 0.0001$), general would infection ($P < 0.0001$), pneumonia ($P < 0.0001$), occurrences of unplanned intubation (0.0002), UTI ($P < 0.0001$), and readmission ($P < 0.0001$).

Discussion

The aim of this study was to assess the risk of perioperative complications of TJA in patients on a regimen of corticosteroids for chronic disease. The results showed that patients undergoing chronic treatment with corticosteroids experienced a statistically significant increase in surgical site infection, deep incisional surgical site infection, organ space surgical site infection, wound dehiscence, general wound infection, pneumonia, reintubation, UTI, and readmission. However, these patients did not

Table 2

Univariate Analysis of 30-Day Perioperative Mortality and Morbidity in Patients Prescribed Corticosteroids for a Chronic Condition and No Corticosteroid Use

	No Steroid Use (n = 388,792)		Steroid Use (n = 14,774)		
Perioperative Complication	**n**	**%**	**n**	**%**	***P* Value**
Mortality	6	0.0015	0	0	0.6326
Surgical site infection	2,126	0.55	116	0.79	0.0001
Deep incisional surgical site infection	727	0.19	54	0.37	<0.0001
Organ space surgical site infection	982	0.25	64	0.43	<0.0001
Wound dehiscence	668	0.17	56	0.38	<0.0001
Any wound infection	4,247	1.09	269	1.82	<0.0001
Pneumonia	1,212	0.31	117	0.79	<0.0001
Reintubation	583	0.15	40	0.27	0.0002
Venous thromboembolic event	1,672	0.43	57	0.39	0.4191
Failure to wean off ventilator	249	0.06	14	0.09	0.151
UTI	3,120	0.80	187	1.27	<0.0001
Postoperative cerebrovascular accident	349	0.09	19	0.13	0.1247
Cardiac arrest	297	0.08	17	0.12	0.098
Myocardial infarction	843	0.22	36	0.24	0.4921
DVT	2,487	0.64	108	0.73	0.1728
Sepsis	11	0.003	0	0	0.5179
Readmission	844	0.22	50	0.34	<0.0001

DVT = deep vein thrombosis, UTI = urinary tract infection

experience increased rates of overall mortality. We also found that the difference in baseline characteristics of patients taking regimens of chronic corticosteroids versus the control group were statistically significant, reflecting higher comorbidities in the corticosteroid group.

Our result of increased risk of perioperative infection in chronic corticosteroid users is consistent with previous findings.[14-17] The goals of the previous studies were to identify risk factors for TJA infection rather than to identify complications related to chronic corticosteroid use. Therefore, previous publications do not differentiate between the types of infections caused by corticosteroids. Our results show that the rates of all types of surgical site infections are increased in TJA patients prescribed chronic corticosteroids. UTIs were also found at a higher rate in the population taking chronic corticosteroids. Although there is very little literature addressing nosocomial UTIs as a complication of arthroplasty, Alvarez et al[18] did identify chronic corticosteroid use as an independent risk factor for UTI in TJA. There are also no known studies directed at exploring pneumonia as a complication of patients receiving chronic corticosteroids and receiving TJA. These complications are likely attributed to the immunosuppressive effects of corticosteroids. The decreased ability of the immune cells to infiltrate the surgical site leads to less immune activity and a greater likelihood that a pathogen will colonize the site.[7,9] The systematic effects of the drug also decrease immune function in the urinary tract and respiratory system, leading to increased risk of developing an UTI or pneumonia, respectively.

Wound dehiscence was also found to be increased by a statistically significant margin in patients taking chronic corticosteroids. No previous studies exist demonstrating the relationship between dehiscence and chronic corticosteroids in arthroplasty surgeries; however, there are studies that demonstrate an increased prevalence of wound dehiscence with corticosteroid use in other surgeries, such as abdominal and colorectal incisions.[19,20] Another study, completed by Ismael et al,[8] used the ACS-NSQIP database and demonstrated an increase in wound dehiscence in chronic corticosteroid users across all types of surgery. This effect may be explained by the ability of corticosteroids to depress the proliferation of fibroblasts and inhibit the ability to remodel collagen.[7,9]

It is also notable that mortality, venous thrombus emboli (VTE), failure to be weaned from ventilation after 48 hours, postoperative cerebrovascular accident, cardiac arrest, myocardial infarction, DVT, and sepsis did not occur at a statistically significant

increased rate. There is literature that shows that high concentrations of cortisol is linked to higher prevalence of both VTE and DVT.[21,22] However, we found no evidence of increased risk for clotting events in our study. The only other investigation into postarthroplasty VTE and chronic corticosteroid use was also performed using the ACS-NSQIP database.[13] The absence of an increased rate of perioperative sepsis is surprising. Although perioperative infection rates did increase with chronic corticosteroid use, the incidence of sepsis did not. Although there is no known literature assessing the risk of sepsis due to chronic steroid use in TJA, there are a few studies that show that there is an increased risk of sepsis in patients undergoing other surgeries who are on chronic corticosteroids.[23,24] The absence of an increased risk of sepsis may be due to the immunomodulating effects of corticosteroids; although some literature has demonstrated a decrease in mortality from septic shock among corticosteroid users,[25] others have shown no difference in mortality rates.[26] Therefore, further study is warranted to explore the relationship between postoperative TJA sepsis and chronic corticosteroid use.

This study is not without several limitations. First, the statistically significant differences existed in baseline characteristics between the control group and those who were on regimens of chronic corticosteroids. The goal of this study, however, is not to prove chronic corticosteroid use as an independent, causative risk factor for TJA complications. Instead, it demonstrates that patients receiving chronic corticosteroid treatment are associated with more comorbidities than the general population at baseline, and this population consequently features a higher risk for specific perioperative morbidities. This study is useful for surgeons, allowing them to consider a broader increased risk of specific perioperative complications in patients prescribed chronic corticosteroids. As with any large database study of this scale, it is difficult to eliminate mistakes in the recording of patient information, and a subset of patients may have been inadvertently included or excluded. Finally, there is a lack of data on the dose of corticosteroids taken by the patients. Further study in which patients are stratified by high- or low-dose chronic corticosteroids would be useful.

Conclusion

Corticosteroid use for a chronic condition for patients who underwent TJA were found to be independently associated with multiple perioperative complications. Further study of complication incidences in relation to corticosteroid use can help improve preoperative planning, optimization, and postoperative monitoring. Risk stratification can result in an improvement of postoperative complications.

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