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Complications - Infection

Single-Dose Perioperative Antibiotics Do Not Increase the Risk of Surgical Site Infection in Unicompartmental Knee Arthroplasty

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ABSTRACT

Background: Unicompartmental knee arthroplasty (UKA) is commonly performed as an outpatient procedure. To facilitate this process, a single-dose intravenous (IV) perioperative antibiotic administration is required compared to 24-hour IV antibiotic dosing schedules that are typical of most inpatient arthroplasty procedures. There is a paucity of literature to guide surgeons on the safety of single-dose perioperative antibiotic administration for arthroplasty procedures, particularly those that will be performed in the outpatient setting. The purpose of this study is to evaluate a large series of UKA performed with single-dose vs 24-hour IV antibiotic coverage to determine the impact on risk for surgical site infection (SSI).

Methods: All UKA cases were evaluated from 2007 to 2017 performed by a single surgeon at an academic institution. There were 296 UKAs in the cohort: 40 were outpatient procedures receiving single-dose antibiotics and 256 were inpatient procedures receiving 24-hour antibiotics. No patients were prescribed adjuvant oral antibiotics. Mean age was 64 years, 50% were female, mean body mass index was 32 kg/m^2, and mean follow-up was 4.1 years (range 1.0-10.4). Perioperative antibiotic regimen was evaluated and SSI, defined as occurring within 1 year of surgery, was abstracted through a prospective total joint registry and manual chart review.

Results: SSI occurred in 2 of 296 cases (0.7%) in the entire cohort, 2 of 256 inpatient UKAs (0.8%), and 0 of 40 outpatient UKAs (0%) ($P = 1.00$). One SSI was a deep infection occurring 6 weeks postoperatively that required 2-stage exchange and conversion to total knee arthroplasty. The other was a superficial infection treated with 2 weeks of oral antibiotics.

Conclusion: This study demonstrates a low SSI risk (0.8% or less) following UKA with both single-dose and 24-hour IV antibiotics. Administering single-dose perioperative antibiotics is safe for UKA, which should alleviate that potential concern for outpatient surgery.

Level of Evidence: Level III, Therapeutic.

Joint arthroplasty procedures are trending toward shorter hospital stays with some patients deemed candidates for outpatient surgery. Among arthroplasty procedures of the hip and knee, unicompartmental knee arthroplasty (UKA) is perhaps most amenable to outpatient surgery given the less invasive nature of the operation [1]. Enhanced perioperative management pathways in conjunction with alterations in reimbursement structure are primary factors driving this phenomenon. However, concern has been raised over the safety of outpatient arthroplasty surgery given reduced time to monitor patients for adequate pain control and overall systemic wellness. Perhaps an underappreciated compromise inherent to outpatient surgery is alteration in the antibiotic regimen. In order to facilitate outpatient surgery, single-dose intravenous (IV)

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perioperative antibiotic administration is required compared to typical 24-hour IV antibiotic dosing schedules.

Despite recommendations from the Centers for Disease Control (CDC) and World Health Organization (WHO) [2] that a single dose of preoperative antibiotic is a sufficient prophylaxis for all surgical procedures, 24-hour IV antibiotic dosing has remained the gold standard for joint arthroplasty [3–7]. A preponderance of the literature guiding the CDC and WHO recommendations is based on procedures from general surgery and related subspecialties that do not entail implantation of foreign material. Surgical site infection (SSI) is one of the most feared complications in joint arthroplasty leading to significant patient morbidity and utilization of healthcare resources [8]. Perioperative antibiotic prophylaxis is a cornerstone of the multifaceted prevention strategy for SSI. A recent meta-analysis evaluated 14 available randomized clinical trials comparing single-dose vs 24-hour antibiotic regimens for orthopedic procedures involving hardware implantation; 7 of these trials focused on arthroplasty patients. Composite analysis found that the rate of infection was 1.9% for both the single-dose and 24-hour antibiotic cohorts [2,9–22]. However, the evidence from these trials was deemed low quality secondary to methodological flaws, heterogeneity of antibiotic regimens and patient populations, and differing definitions of infection. Further literature is needed to guide orthopedic surgeons on the safety of single-dose perioperative antibiotic administration for arthroplasty procedures, particularly those that will be performed in the outpatient setting. The purpose of this study is therefore to evaluate a large series of UKA performed with single-dose vs 24-hour IV antibiotic coverage to determine the impact on the risk for SSI.

Patients and Methods

After obtaining Institutional Review Board approval, we queried our prospectively collected Total Joint Registry to identify all patients who underwent UKA performed by a single senior arthroplasty surgeon between January 1, 2007 and December 31, 2017. Surgical indications of the senior author followed a modified version of the Kozinn and Scott criteria [24,25]. Patients had degenerative changes limited to a single compartment of the tibiofemoral articulation, correctable varus deformity less than 15°, normal cartilage thickness of the uninvolved contralateral compartment (verified clinically and radiographically with valgus/varus stress radiographs), flexion of at least 100°, and intact cruciate and collateral ligaments. Patients were not offered a UKA if they did not fulfill the aforementioned criteria or if they had one of the following exclusion criteria: severe patellofemoral degenerative changes, contralateral compartment involvement, fixed flexion contracture greater than 15°, or previous diagnosis of inflammatory arthritis.

We identified 366 UKAs in 292 patients. We excluded all patients with less than 1 year of follow-up, yielding a final cohort of 296 UKAs in 238 patients who underwent full manual chart review. There were 293 medial UKAs and 3 lateral UKAs. Over the evaluated time period, 35 patients (40 UKAs) were managed in the outpatient setting and 209 patients (256 UKAs) were treated as inpatients with at least a one night stay in the hospital. There were no systematic criteria applied to which patients were treated as outpatients vs inpatients. Outpatient group allocation was planned, performed at the preoperative visit, and required approval of the surgeon as well as the patient. Planned outpatients who required admission received the standard inpatient antibiotic regime and were considered in the latter group. All patients treated in the outpatient setting received single-dose IV antibiotics prior to surgical incision. For both groups, a first-generation cephalosporin was used as the preferred regimen, typically with cefazolin. Patients with prior history of allergic reactions and positive allergy test received an alternative antibiotic, most commonly vancomycin or clindamycin. If methicillin-resistant *Staphylococcus aureus* colonization was proven, dual antibiotic therapy with cefazolin and vancomycin was given. All inpatients received 24-hour coverage with IV antibiotics. Outpatients were discharged prior to the second antibiotic dose. Other than duration of therapy, there was no difference in the IV antibiotic regimes between groups. No patients in the study received adjuvant oral antibiotics. The remaining perioperative management was similar for both groups, consisting of a periarticular local anesthetic block, acetaminophen, nonsteroidal anti-inflammatory drugs, an opioid, a gamma-amino butyric acid analog, tranexamic acid, and deep venous thrombosis prophylaxis. Rarely, patients received intraoperative or perioperative steroids. All UKAs were cemented and antibiotic cement with a heat stable agent was used preferentially in both groups.

Patients managed as inpatients vs outpatients formed the 2 primary cohorts with subsequent evaluation of survivorship free from infection as the primary outcome measure. Given the evolving definitions and criteria for postoperative infection, a temporally consistent measure of SSI was provided on the basis of clinical examination and laboratory results deemed consistent with infection (ie, leading to surgical intervention or antibiotic suppression) on the basis of independent, third-party review of all data by formally trained Total Joint Registry staff. Our Total Joint Registry contacts patients at routine intervals (postoperatively at 2 years, 5 years, and every 5 years thereafter) to screen for complications identified and treated at outside institutions to complement data from internal patient management.

The outpatient cohort consisted of 22 females (55%) with a mean age of 62.2 years (range 47-77), mean body mass index (BMI) of 31.6 kg/m^2 (range 17.8-62.1), and 20% of patients with American Society of Anesthesiologists (ASA) class ≥3. Mean follow-up time was 27 months (range 12-103) (Table 1). The inpatient cohort consisted of 125 females (49%) with a mean age of 63.8 years (range 20-92), mean BMI of 31.7 kg/m^2 (range 17.9-60.9), and 20% of patients with ASA class ≥3. Mean follow-up time was 58 months (range 12-125) (Table 1). There were no significant differences in age, gender, ASA class, or BMI between the cohorts (smallest $P = .25$); however, mean follow-up time was significantly longer for the inpatient group ($P < .001$) secondary to the fact that all patients were treated as inpatients in the earliest years of the senior author's practice.

Statistical Methods

Continuous variables were analyzed with means and ranges and categorical variables as counts and percentages. Differences

Table 1
Demographics.

Variables	Single Dose	24-Hour Dose	*P*-Value
Gender			
Female	55%	49%	.77
Male	45%	51%	
Age	62.2 (47-77)	63.8 (20-92)	.12
BMI	31.6 (17.8-62.1)	31.7 (17.9-60.9)	.19
ASA classification			
I	3	7	.88[a]
II	29	198	
III	8	50	
IV	0	1	
Follow-up (mo)	27 (12-103)	58 (12-125)	<.01

ASA, American Society of Anesthesiologists; BMI, body mass index.
[a] Patients ASA score ≥3.

Table 2
Infections by Antibiotic Group.

Infection Type	All Patients (n = 296)	Single Dose (n = 40)	24-Hour Dose (n = 256)	*P*-Value
Superficial	1 (0.3%)	0 (0%)	1 (0.4%)	1.00
Deep	1 (0.3%)	0 (0%)	1 (0.4%)	1.00
Combined	2 (0.7%)	0 (0%)	2 (0.8%)	1.00

between the groups were assessed by means of the Wilcoxon signed-rank test for continuous variables, whereas categorical data were analyzed with the Fisher's exact test. Statistical significance was set at $\alpha < 0.05$. All statistical tests were performed with JMP statistical software.

Results

Among all 296 UKAs evaluated, SSI occurred in 2 (0.7%) UKAs. There was no significant difference between groups: the outpatient cohort sustained 0 SSIs (0%), whereas the inpatient cohort sustained 2 SSIs (0.8%) ($P = 1.00$; Table 2). One SSI was a deep infection and the other was a superficial infection. The lone superficial wound infection occurred 6 weeks after surgery in a patient with significant comorbidity classified as ASA 3 (Table 3). The patient was treated in an outpatient fashion with oral cephalexin 500 mg 4 times daily for 2 weeks. No surgical intervention was required and no further complications have been identified at 70 months of follow-up. The deep SSI was admitted and initially treated with irrigation, debridement, polyethylene exchange, and IV antibiotics. However, this patient eventually required 2-stage exchange to a total knee arthroplasty (Table 3). Further patient details are shown in Table 3.

Discussion

Joint arthroplasty procedures including UKA are trending toward shorter hospital stays with some patients deemed candidates for outpatient surgery. Although outpatient surgery holds many attractive advantages for patients, it is critical for surgeons to ensure this does not compromise patient safety and complication risk. SSI is one of the most feared complications following joint arthroplasty and perioperative antibiotic prophylaxis is known to be one of the fundamental steps in preventing this outcome. Although inpatients can be managed with a traditional 24-hour regimen of IV antibiotic coverage, outpatient surgery necessitates patients only receive a single-dose IV antibiotic course. The purpose of this study is to evaluate a large, single-surgeon cohort of UKA patients treated as inpatients and outpatients with subsequent evaluation of impact on SSI risk. We found that PJI was rare (0.7% overall) and was not significantly different between inpatients as compared with outpatients, suggesting that single-dose perioperative IV antibiotic prophylaxis is a safe practice for outpatient UKA.

The CDC and WHO have recently recommended that a single dose of perioperative IV antibiotics should serve as the standard of care for all surgical procedures [2]. Assessment of a large body of evidence suggests that this is safe and sufficient for preventing SSIs. There are noted advantages to restricting antibiotic administration to the minimum necessary dose. This practice decreases the overall cost of care and facilitates antibiotic stewardship by slowing development of resistant organisms. It also decreases the likelihood of adverse events related to antibiotics such as *Clostridium difficile* infections, allergies, and renal impairment. However, the new guidelines were based in large part on nonorthopedic surgical procedures that do not use implants. This raises concern that a one-size-fits-all policy could potentially compromise patient safety as SSI is one of the most serious complications related to arthroplasty. Previous work has investigated the efficacy of single dose vs 24-hour dosing for preventing SSI in orthopedic procedures. A recent meta-analysis evaluated 14 randomized clinical trials comparing single-dose vs 24-hour antibiotic regimens. All these trials were conducted in patients receiving orthopedic hardware and 7 of the trials were performed in arthroplasty patients. In total, these trials evaluated 9691 patients and found an identical overall rate of infection at 1.9% for both the single-dose and 24-hour antibiotic prophylaxis cohorts [10–23]. Although these studies involved heterogeneous populations, inconsistent definitions of infection, and variable treatment algorithms, the results are quite similar to our study of UKA patients. We found an overall SSI rate of 0.7% with no significant difference between the single-dose and 24-hour antibiotic prophylaxis cohorts.

This study must be interpreted in light of important limitations. First, this is a single-surgeon series and as such may not be applicable to other practices. Second, over the course of the study period, there were no systematic criteria applied to which UKA patients were managed as inpatients vs outpatients. However, all of the outpatients were derived from the latter years of the cohort reflecting evolving practice patterns and improved perioperative management pathways. Third, given the low number of SSI events, we are unable to perform analysis of patient-specific factors that may contribute to SSI risk. Fourth, all patients treated as inpatients in this study received 24-hour coverage with IV antibiotics. Therefore, we are unable to comment on the safety of single-dose IV antibiotic regimens for patients treated as inpatients. Fifth, not all patients in the study were treated with the same antibiotic. Cefazolin was always the first line option; however, in cases of methicillin-resistant *S aureus* colonization or antibiotic allergy, vancomycin or clindamycin was used. Furthermore, antibiotics were not used in cement in every case. The overall frequency of adding a heat stable antibiotic to cement was 81%. Although antibiotic in the cement might be a confounder for which we did not account for, to date, benefits remain uncertain [25–27].

This study demonstrates a similar rate of SSI following UKA between patients treated as outpatients with single dose compared to inpatients with 24-hour IV antibiotic prophylaxis. As improved perioperative management pathways lead to increasing volumes of arthroplasty patients managed in the outpatient setting, it is critical that surgeons ensure this does not compromise patient safety. Although a multitude of factors must be considered in this decision for each patient, our data suggest that shortening IV antibiotic coverage to accommodate outpatient surgery does not increase SSI risk. Further study will be

Table 3
Characteristics of Each Patient Sustaining Infection.

Age	Gender	BMI	ASA	Antibiotic Regimen	Time to Infection	Type of Infection	Organism	Treatment
43	Female	21	II	24 h	0.5 mo	Deep	Streptococcus	I&D, polyexchange, 6-wk IV antibiotics, 2-stage exchange to TKA
75	Male	29	III	24 h	1.5 mo	Superficial	Unidentified	2-wk oral antibiotics

ASA, American Society of Anesthesiologists; BMI, body mass index; I&D, irrigation and debridement; IV, intravenous; TKA, total knee arthroplasty.

mandatory to determine if single-dose IV antibiotic prophylaxis achieves equal efficacy in the inpatient setting.

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