

Urinary tract infections after early removal of urinary catheter in total joint arthroplasty

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Abstract. – OBJECTIVE: Postoperative urine retention (POUR) is a well-known complication after total joint arthroplasty (TJA). POUR is most commonly managed with an indwelling catheter. However, indwelling catheters have been associated with a substantial risk of urinary tract infection (UTI). The purpose of this study was to (1) evaluate the incidence of UTI and POUR in patient with indwelling urinary catheter after TJA, (2) identify the microorganisms responsible for catheter colonization, and (3) assess pre-operative risk factors (gender, body mass index, hypertension, diabetes mellitus, smoking) associated with catheter colonization.

PATIENTS AND METHODS: Patients undergoing primary TJA with no preoperative bacteriuria were enrolled. Prior to the draping of the surgical site, each patient received an indwelling catheter that was inserted under sterile conditions and remained in place for 24 hours. Urine and tip catheter cultures were performed after catheter removal.

RESULTS: 55 patients (38 females and 17 males) were recruited (26 total knee and 29 total hip arthroplasties). POUR was not reported in any patient, and only 1 patient (1.8%) had UTI. Cultures of catheter tips were positive in 16 patients (29.1%). Only 1 of these patients had a positive urine culture. *Enterococcus faecalis* was the most common pathogen isolated. None of the preoperative variables was associated with the risk of catheter colonization.

CONCLUSIONS: Data from this study support early catheter removal after TJA. Predominant catheter-isolated bacteria are enteric species. The culture of a catheter tip specimen should be discouraged for the diagnosis of UTI within the firsts 24 hours after surgery.

Key Words

Urinary tract infection, Urinary retention, Urinary catheterization, Total joint arthroplasty

Introduction

Voiding problems after total joint replacement and other surgical procedures may increase morbidity and medical expenses¹. Postoperative urine retention (POUR) is a well-known complication

in hip (THA) and knee arthroplasty (TKA), with a variable incidence of 8% to 55%². POUR does not carry a high risk of morbidity when managed properly³. However, failure to identify this condition may lead to serious clinical sequelae, such as prolonged bladder distention, urinary tract infection (UTI) and detrusor dysfunction³. POUR is most commonly managed using an indwelling Foley catheter or by intermittent catheterization. Previous studies compared an indwelling catheter and intermittent catheterization in THA and TKA and favored an indwelling catheter because of lower bacteriuria and urinary retention rate⁴. However, indwelling Foley catheters are associated with a substantial risk of UTI. UTI is directly related to the time of catheterization, and the risk was estimated at 5% to 10% per catheter-day after the first 48 hours of catheterization⁵. The risk of mortality increases by a factor of 3 in patients with a UTI, and there is an increased risk of metastatic infection around joint replacements. However, the statistical significance of these risks remains controversial⁶. Bacteria gain access to the bladder during catheter insertion, and the pathogenesis of catheter-related urinary tract infection (CAUTI) is related to the susceptibility of the inert catheter material to microbial colonization and biofilm formation^{7,8}. A biofilm on an indwelling urinary catheter consists of adherent microorganisms, their extracellular products, and host components deposited on the catheter. The biofilm lifestyle conveys a survival advantage to microorganisms because it improves the ability of microorganisms to withstand drying, shear forces, and antimicrobial agents. An indwelling urinary catheter generally cannot usually be cleared of a pathogenic biofilm without catheter removal⁷. Biofilm-associated organisms continue to seed the urine with bacteria as long as the colonized catheter remains in place, which may cause UTI⁹. However, the risk of catheter colonization is much higher than urinary infection and positive culture of a catheter tip specimen is not indicative of UTI¹⁰⁻¹². The commonly detected CAUTI microorganisms are members of

fecal microbial communities, such as *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, Enterococci, Klebsiella species, and Citrobacter species, and coagulase-negative staphylococci, *Candida albicans*, and other species are occasionally involved¹³.

Previous studies demonstrated that the use of specific indwelling urinary catheter protocols prevent CAUTI¹⁴. This prospective observational cohort was performed to (1) evaluate the incidence of CAUTI and POUR in patients with an indwelling urinary catheter after total joint arthroplasty (TJA), (2) identify the microorganisms responsible for catheter colonization, and (3) assess preoperative risk factors associated with catheter colonization.

Patients and Methods

This prospective study was approved by the Researchers Ethics Committee and was conducted in accordance with the Declaration of Helsinki and the Guideline for Good Clinical Practice. From October 2015 to April 2017 we enrolled patients who were scheduled to undergo TKA or THA. Exclusion criteria were history of chronic or recurrent UTI, perioperative steroid administration, long-term antibiotic therapy, allergic reactions to beta-lactams, chronic hepatitis, immunodeficiency disorders, preoperative bacteriuria or UTI. All of the participants signed a written informed consent prior to enrollment. Urinalysis of a midstream clean-catch urine specimen was performed one day prior to surgery to ensure the absence of bacteria or white blood cells preoperatively. All patients routinely received a 2-g dose of cefazolin intravenously 30 minutes prior to skin incision or tourniquet inflation¹⁵. Patients received an indwelling Foley catheter prior to the draping of the surgical site. The Foley catheter was inserted under sterile conditions, connected to a closed-drainage system, and remained in place for 24 hours. Sterile catheterization involved 'scrubbing' for 4 minutes, gowning up, wearing sterile gloves and using strict aseptic technique. The patient was placed in a supine position, and a sterile catheterization pack was used. The patient's external urethral meatus was carefully cleaned using a povidone-iodine solution. The sterile catheter was lubricated with sterile lidocaine gel and introduced into the urethra. Sterile water was used to inflate the balloon. Cefazolin (2 g) was administered 12, 24, and 36 hours postoperatively. The catheter

was carefully removed under sterile conditions one day after surgery, and the tip was placed in a sterile tube, which was forwarded to the clinical bacteriology laboratory for culture. Urinalysis of the first spontaneous micturition with culture for microorganism was performed on a clean catch midstream urine sample. Postoperative bacteriuria or UTI was defined as a positive urine sediment for bacteria or white blood cells with a positive urine culture of >100,000 colonies¹⁶. Patients were clinically evaluated 1, 3, and 6 months postoperatively for post-discharge surveillance of surgical site infection and UTI.

Statistical Analysis

Descriptive statistics were used to describe continuous variables, and proportions were used for categorical variables. The Student's *t*-test and the χ^2 -test were used to evaluate the significance of differences. Models of univariate linear regression analysis were created to test the effect of patient gender, body mass index, hypertension, diabetes mellitus and smoking on catheter colonization. IBM SPSS Statistics 21.0.0.1 software (IBM Corp, Armonk, NY, USA) was used for database construction and statistical analyses.

Results

A total of 104 patients (66 females and 38 males) underwent primary total joint arthroplasty. Fifty-five patients (38 females and 17 males) were recruited for this study (26 TKA and 29 THA) after a detailed clinical history and laboratory examination. Preoperative positive urinalysis was the most common cause of exclusion (Table I). Table II shows the demographics of the study cohort. Urinary retention was not reported in any patient after catheter removal, and only 1 patient (1.8%) had UTI. This patient was a 60-year-old woman subjected to TKA who developed fever (38°C) dysuria, urinary frequency, and bladder tenesmus 12 hours after catheter removal. She exhibited no chronic comorbidities, and laboratory data revealed mild leukocytosis (15.300/mL) with neutrophilia (80%). Microbial cultures of the catheter tip and urine revealed the growth of *Pseudomonas aeruginosa*. Antimicrobial susceptibility testing demonstrated resistance to cefazolin and susceptibility to fluoroquinolones. The patient's condition improved gradually after treatment with 250 mg oral ciprofloxacin administration every 12 h for 7 days. Cultures of catheter tips were positive

Table I. Reasons for exclusion of patients.

N	Reason for exclusion
30	bacteriuria
9	medical history of UTI
7	chronic epatitis
6	allergic reactions to beta-lactams
4	glucocorticoid treatment
3	immunodeficiency disorders

in 15 other patients (27.2%). The urine culture was negative for microorganisms in all of these patients. *Enterococcus faecalis* was the most common pathogen isolated from catheter tip culture (9 of 16 patients). The other pathogens were *Candida spp* (3 patients), *Escherichia coli* (2 patients), *Pseudomonas aeruginosa* (2 patients), *Morganella morganii spp* (2 patients), *Citrobacter freundii* (1 patient), *Klebsiella pneumoniae* (1 patient), and *Providentia stuartii* (1 patient). Polymicrobial contamination was observed in 4 patients. No patient exhibited clinical symptoms or signs of UTI at follow-up. None of the preoperative variables was associated with the risk of catheter colonization.

Discussion

The current study demonstrated that patients undergoing TJA exhibited a 1.8% rate of CAUTI and no POUR after the use of a specific protocol for the management of indwelling urinary catheters. Previous studies demonstrated that POUR and CAUTI were frequent complications in orthopedic surgery, with incidence rates as high as 75% and 32%, respectively¹⁷. Knight et al⁴ demonstrated that the use of an indwelling Foley catheter for the first 48 hours after TJA was associated with a significantly faster return of normal bladder function, and it was more cost effective than intermittent catheterization. Previous studies found that the duration of catheterization was the greatest and most important risk factor for the development of a UTI. The risk of infection was estimated at approximately 5% per day for short-term catheter use¹⁸. Wald et al⁵ found that indwelling urinary catheters that remained in situ longer than 48 hours postoperatively resulted in twice the number of UTIs compared to patients whose urinary catheters were removed within or less than 48 hours in a large retrospective cohort study. Therefore, catheter restriction protocols are an effective strategy to decrease CAUTI rates¹⁹.

Table II. Patient demographics and characteristics.

	N	%
Age	67.1±11.5 (30–87)	
BMI	30.5±6.9 (16.7–50.2)	
Operative diagnosis		
Osteoarthritis	49	89.1
Rheumatoid arthritis	3	5.5
Osteonecrosis	2	3.6
Fracture	1	1.8
Comorbidity		
Hypertension	40	72.7
Diabetes	15	27.3
Smoke	9	16.4
Chronic kidney disease	2	3.6

The protocol used in the current study did not provide specific catheter antibiotic prophylaxis and early catheter removal (i.e., 24 hours postoperatively) may explain the low rate of CAUTI. Scarlato et al²⁰ demonstrated that the combination of standard surgical antimicrobial prophylaxis and specific catheter prophylaxis (80 mg of gentamicin prior to catheter removal) reduced the incidence of postoperative bacteriuria. However, antibiotic prophylaxis at the time of catheter removal dramatically increased antibiotic consumption and resistance²¹. Evidence in other branches of medicine and surgery suggests that antibiotic prophylaxis is not needed when a catheter is removed, and we are not aware of any evidence to support antibiotic coverage when catheters are removed in orthopedic patients^{22,23}.

We administered cefazolin for antibiotic prophylaxis according to the previous recommendations¹⁵. Cephalosporins exhibit a good safety profile and coverage against *Staphylococcus aureus* and some Gram-negative organisms, which are the most prevalent organisms in prosthetic-related infections²⁴. Cefazolin antimicrobial prophylaxis may also reduce the incidence of catheter-associated bacteriuria²⁵. The optimal duration of antimicrobial prophylaxis has been debated in the last years²⁶. In our protocol, the duration of postoperative prophylaxis was 36 hours according to recent guidelines that recommend a window of post-operative prophylaxis ranging from 24 to 36 hours²⁷. Some studies showed that bacteriuria can persist after catheter removal and that the manipulation of the catheter during removal might also predispose to infection^{21,28}. In this light, in the current study, the last dose of antibiotic was administered 12 hours after the catheter removal (i.e., 36 hours after surgery).

The current study demonstrated that POUR was avoided after TJA with the use of indwelling catheterization for 24 hours. The avoidance of urinary retention and subsequent bladder distention is desirable because patients with urinary retention after TJA are at increased risk of implant infection²⁹. Our results are consistent with the observations of Farag et al³⁰ who reported no episodes of urine retention with indwelling catheter removal 24 hours after TKA. Notably, Oishi et al³¹ demonstrated that an indwelling catheterization protocol significantly reduced the incidence of urinary retention and bladder distention after TJA compared to an intermittent catheterization protocol.

Only one patient in the current study with a positive tip culture developed CAUTI. The risk of catheter colonization is much higher than urinary infection³². Urine constantly flows from the bladder into the drain bag, and a variety of host mechanisms that prevent bacterial colonization and survival maintain the sterility of the urinary tract. Therefore, colonization of the bladder mucosa and invasion of the mucosal surface is much more challenging than catheter colonization during the first days postoperatively. Matsukawa et al³³ demonstrated no significant differences between urine and catheter culture ratios in patients with an indwelling catheter for 7 days or longer. These data suggest that catheter colonization is an essential step of urinary tract infection and precedes urine colonization. The discrepancy between the number of UTI (1 patient) and positive catheter tip culture (16 patients) in the current study demonstrated that positive catheter tip culture was not indicative of UTI within the first 24 hours after surgery. The use of tip catheter cultures to diagnose of CAUTI should be discouraged, according to previous studies¹⁰⁻¹².

To the best of our knowledge, this report is the first study to examine the early microbial colonization of urinary catheters after TJA. Most of the isolated pathogens were part of the patients' endogenous bowel flora, and their migration extraluminally into the periurethral space is a major pathway for bladder entry. Colonization of the urethral meatus is a major risk factor for catheter-associated bacteriuria³⁴. Chronic renal failure, gender, diabetes mellitus, hypertension, and smoking did not influence the process of bacterial colonization. Conversely, Mac Leone et al³⁵ found that female gender was a risk factor for catheter colonization.

Some limitations should be considered when interpreting the results of this study. The small sample size may have obscured some signifi-

cant differences³⁶ and the associations of some comorbidities and POUR and UTI. This study involved a single medical center, and the results warrant further testing in other institutions using this specific indwelling catheterization protocol. Lastly, the current study is not comparative in nature, and the limits arising from the lack of a control group should be considered.

Conclusions

The data from this study supports early catheter removal after TJA. Predominant catheter-isolated bacteria are enteric species. A discrepancy between the number of UTI and positive catheter tip cultures demonstrated that culture of a catheter tip specimen should be discouraged for the diagnosis of CAUTI within 24 hours after surgery. Future improvements to the survey process and data analysis and reporting on catheter use and adverse events could provide useful information for unresolved issues in CAUTI prevention. Examples include the use of antiseptic solution versus sterile saline for meatal cleaning prior to catheter insertion or the routine use of catheters with valves or biocidal coatings. Our data may be helpful in discussions of the risks of indwelling urinary catheters with patients and families.

Conflicts of interest

The Authors declare that they have no conflict of interests.

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