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Intraoperative chlorhexidine irrigation to prevent infection in total hip and knee arthroplasty

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ABSTRACT

Background: Surgical site irrigation during total hip (THA) and total knee (TKA) arthroplasty is a routine practice among orthopaedic surgeons to prevent periprosthetic joint infection. The purpose of this study was to evaluate the effect of chlorhexidine gluconate (CHG) irrigation on infection rates following THA and TKA.

Methods: Arthroplasties performed before September 2014 served as controls. THA performed before September 2014 (N = 253) underwent intraoperative irrigation with 0.9% saline followed by a 2-minute soak with <2% dilute povidone-iodine. TKA (N = 411) patients underwent only intraoperative saline irrigation. After October 2014, all patients (248 TKA and 138 THA) received intraoperative irrigation with 0.9% saline and periodic 0.05% CHG solution followed by a final 1-minute soak in CHG with immediate closure afterward.

Results: In this 2:1 comparison of consecutive patients, there were no differences in patient demographics between the 2 groups. No difference was noted in wound healing concerns subjectively, and no statistically significant association in nonsurgical site infections, superficial surgical site infection, and deep surgical site infection rates between the 2 groups (nonsurgical site infections [THA: $P = .244$, TKA: $P = .125$]; superficial surgical site infection [THA: $P = .555$, TKA: $P = .913$]; and deep surgical site infection [THA: $P = .302$, TKA: $P = .534$]).

Conclusions: We were unable to discern a difference in infection rates between chlorhexidine irrigation and our prior protocols using dilute Betadine for THA and 0.9% saline for TKA. The theoretic advantages of dilute CHG retention during closure appear to be safe without infectious concerns.

Introduction

There is little standardization pertaining to wound irrigation to prevent surgical site infection [1]. Infections continue to be a dreadful and costly complication in total joint arthroplasty (TJA). The estimated cost of periprosthetic joint infections (PJIs) due to sensitive organisms is known to be over $60,000 dollars [2] and over $100,000 dollars for methicillin-resistant organisms [3] per case. Despite our best efforts, PJI occurs in approximately 0.8%-1.9% of total knee arthroplasty (TKA) and 0.3%-1.7% of total hip arthroplasty (THA) [4]. PJI after TKA is the single leading cause of early revision, accounting for 25.4% of revisions within the first 2 years after surgery and 7.8% thereafter [5]. THA infections are the third leading cause of revision accounting for up to 14.8% of revision surgeries [4,5]. The demand for TKA and THA is projected to increase by 137% and 601%, respectively, from 2005 to 2030 [6]. As the demand increases, the cumulative associated cost of TJA is projected to exceed $1 billion dollars this year [7].

Preventative measures of joint infection in TJA are constantly evolving [8]. Currently, the use of perioperative systemic antibiotics is the standard of care in joint replacement. It is also the only

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consensus recommendation by international authorities. Other methods to decrease the rate of infection are still under investigation, such as operating room ventilation, body exhaust suits, preoperative patient optimization, intraoperative temperature management, and perioperative skin preparation and wound management. Wound irrigation during arthroplasty is a routine practice among orthopaedic surgeons to prevent PJI. Several potential solutions have been proposed including the use of 0.9% saline, castile soap, antibiotic solutions, and antiseptics like povidone-iodine or hydrogen peroxide, yet no consensus has been reached due to a lack of convincing evidence and a paucity of studies. A majority of surgeons favor 0.9% saline, although studies have shown potential advantages to antibiotic and soap solutions [9-11]. Much of the theoretic advantages have not been borne out in clinical studies.

Given the lack of clinical studies on the topic, a "gold standard" is still missing [12]. The purpose of this study was to determine the effect of chlorhexidine irrigation on infection rates following THA and TKA. Chlorhexidine gluconate (CHG) has advantages of being a potent antiseptic with broad-spectrum efficacy while still being gentle on native tissue [13,14]. This study is the first to our knowledge to directly examine intraoperative wound irrigation with chlorohexidine in TJA.

Material and methods

We reviewed our first year of experience with a chlorhexidine irrigation with a contemporary 2:1 match of the preceding historical controls. We performed a retrospective review of a prospectively collected database containing 1050 consecutive TJA patients who had undergone primary TKA or THA by a single surgeon at our institution from February 2012 to October 2015. After excluding patients with incomplete data, a total of 906 patients were ultimately included for analysis. Arthroplasties performed before September 2014 served as controls, as chlorhexidine irrigation was not used before this date. There were 411 TKA and 253 THA patients in the control group whereas 248 TKA and 138 THA patients in the chlorhexidine irrigation group.

All surgeries were performed under spinal anesthesia unless otherwise contraindicated. Cementless THA via a modified posterior approach and standard (nonantibiotic) cemented TKA was used in all patients. Skin preparation consisted of 2% chlorhexidine and 70% isopropyl alcohol (ChloraPrep, Carefusion, San Diego, CA) followed by a double-prep with iodine povacrylex in isopropyl alcohol (DuraPrep, 3M, St. Paul, MN) after draping, following by coverage by an iodophor-impregnated incise drape (Ioban 2, 3M, St. Paul, MN). THA performed before September 2014 (N = 664) underwent intraoperative irrigation with 0.9% saline followed by a 2-minute soak with <2% dilute povidone-iodine which was washed out entirely before closure. TKA patients underwent intraoperative irrigation with 0.9% saline as the sole treatment. After October 2014, all TJA (N = 386) patients received intraoperative irrigation with 0.9% saline and periodic 0.05% CHG solution (Irrisept, Irrimax Corporation, Innovation Technologies, Inc., Lawrenceville, GA) followed by a final 1-minute soak in CHG with immediate closure afterward.

All patients were placed on standard joints protocol postoperatively. Preoperative antibiotics were administered within 1 hour of the skin incision, using a single dose of 1-1.5 g of vancomycin and 1-2 g of cefazolin. Only those with anaphylactic allergy to cefazolin were switched to gentamicin. Postoperatively, cefazolin was given for 2 doses to be discontinued within 24 hours. Physical and occupational therapy was initiated on postoperative day 1 and continued until discharge. Although we currently mobilize the day of surgery, at the time of this study period patients would only dangle legs at bedside. Wound healing was assessed daily while patients were in the hospital and again upon follow-up clinical visits. Routine deep venous thrombus prophylaxis was started on postoperative day 1 and continued for 2-5 weeks postoperatively. During the time of this study, patients received aspirin 81 mg twice daily beginning the night of surgery for chemoprophylaxis. Those on more aggressive anticoagulation before surgery were alternatively restarted on their prior regimen. Minimum length of follow-up was 1 year.

Patient demographics including age, body mass index, gender, surgery, and transfusion were included. Nonsurgical site infections (NSSI), superficial surgical site infection (SSSI), and deep surgical site infection (DSSI) rates between the 2 groups were compared. We defined DSSI according to the Musculoskeletal Infection Society guidelines [15]. Statistical analysis was performed using adjusted odds ratios at a 95% confidence interval (CI) and univariate repeated-measures logistic regression models ($P < .05$). Parameters were compared between treatment groups using *t*-tests. Some patients appear up to 3 times in the dataset due to repeat surgeries and/or surgeries on both knees, so a generalized estimating equations approach was taken to account for the lack of independence in these measurements. All analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

A total of 906 patients undergoing TJAs were analyzed. Table 1 shows demographic characteristics of the study cohort and controls. There were no statistical differences between the 2 groups. The mean age of the controls was 65.3 vs 66.5 years in the study cohort. Mean body mass index was 32.0 in each group. Two patients were excluded from the chlorhexidine irrigation group due to traumatic knee injury associated with a significant direct fall at home requiring operative debridement and repeat closure.

A post hoc power analysis was calculated given the low infection rate seen in TJA and found that a 2-group chi-square test with a 0.05 two-sided significance level will have 80% power to detect a difference in proportions of 0.01054 (7/664, preintervention) and 0.00777 (3/386 postintervention) when the sample sizes are 25,629 and 14,901, respectively. This would require a study population of over 40,000. This analysis underscores the difficulty in finding statistically significant differences with the rates of infection in TJA.

There was no statistically significant association in overall infection rates between control and chlorhexidine irrigation solutions. Overall odds ratio and 95% CIs between controls and treatment groups were 1.97 ([0.97, 3.97], $P = .059$); 1.75 ([0.35, 8.70], $P = .494$); and 1.36 ([0.35, 5.29], $P = .6757$) for NSSI, SSSI, and DSSI, respectively.

The prevalence of infections in control groups for TKA was 24 (5.8%), 3 (0.7%), and 3 (0.7%) for NSSI, SSSI, and DSSI, respectively. In the TKA study group, there were 8 (3.2%), 2 (0.8%), and 3 (1.2%) infections for NSSI, SSSI, and DSSI, respectively. Odds ratio and 95% CIs between TKA treatment groups were 1.86 ([0.84, 4.11], $P = .125$) and 0.9 ([0.15, 5.42], $P = .913$) for NSSI and SSSI, respectively

Table 1
Demographic characteristics.

Characteristic	Control (N = 664)	Chlorhexidine (N = 386)	*P* value
Age (y)	65.3	66.5	.065
Blood transfusion rate	10%	0%	
Body mass index (kg/m^2)	32.0	32.0	.996
Right side	356 (54%)	194 (50%)	.268
Female	400 (60%)	231 (60%)	.904

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