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Closed-Incision Negative-Pressure Therapy Versus Antimicrobial Dressings After Revision Hip and Knee Surgery: A Comparative Study

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ABSTRACT

Background: This study evaluates the efficacy of closed-incision negative-pressure therapy (ciNPT) in decreasing wound complications and surgical site infections (SSIs) after revision hip and knee surgery.
Methods: A retrospective quality improvement analysis of 138 consecutive revision hip and knee operations performed by a single surgeon over a 34-month period was performed. ciNPT was used selectively in higher-risk patients with multiple risk factors for SSIs over the last 15 months of the study period. Rates of wound complications, SSIs, and reoperation were compared with patients treated with a sterile antimicrobial dressing.
Results: Antimicrobial dressings were used in 108 patients, whereas ciNPT was used in 30 patients. Patients treated with ciNPT developed fewer overall wound complications (6.7% vs 26.9%, $P = .024$) and fewer total SSIs (3.3% vs 18.5%, $P = .045$) than patients treated with antimicrobial dressings. In addition, there were trends toward a lower rate of superficial wound dehiscence (6.7% vs 19.4%, $P = .163$), fewer deep periprosthetic joint infections (0.0% vs 9.3%, $P = .118$), and fewer reoperations (3.3% vs 13.0%, $P = .191$) among patients treated with ciNPT.
Conclusion: Our findings suggest that ciNPT may decrease wound complications and SSIs in patients undergoing revision hip and knee surgery.

Despite the clinical success and cost-effectiveness of primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) [1,2], the number of revision joint arthroplasties performed in the United States has increased with time [3,4]. Between 2005 and 2010, the revision TKA burden has increased by 39% and the revision THA burden has increased by 23% [5], both of which are projected to continue to rise into the foreseeable future [6,7].

Wound complications and surgical site infections (SSIs) after revision hip and knee surgery are a major source of patient morbidity and represent a substantial health care burden. Compared to primary hip and knee arthroplasty populations, complications with incisions occur more often in patients who have had previous surgery [8-10] and can lead to serious consequences. Schairer et al [8] report a 13%-18% 90-day readmission rate after revision TKA, which occurred most often for problems related to the surgical incision. In addition, deep infection is the leading cause for failure of a revision arthroplasty, with Suarez et al [11] reporting 46% of their failures to be secondary to a periprosthetic joint infection (PJI). Patients who develop SSIs not only face additional morbidity but also represent a significant economic burden with longer and more expensive hospitalizations, greater postdischarge wound-care costs, and more readmissions than noninfected patients [12]. Even patients readmitted for noninfectious wound complications can suffer long-term morbidity and worse clinical outcomes [13].

Great effort has been placed on preventing SSIs after hip and knee surgery. Well-established guidelines for prevention of SSIs have been published by the Institute for Healthcare Improvement [14] and Centers of Disease Control and Prevention (CDC) [15]. The Institute for Healthcare Improvement's “Project JOINTS” (Joining Organizations IN Tackling SSIs) [14] recommends (1) use of an alcohol-containing antiseptic agent for preoperative skin preparation, (2) use of chlorhexidine gluconate (CHG) soap before surgery, (3) preoperative screening for *Staphylococcus aureus* and decolonizing carriers with intranasal mupirocin, (4) appropriate prophylactic antibiotics, and (5) hair removal using clippers. The latter two

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are mandated by the Surgical Care Improvement Project [16]. The CDC recommends a multitude of other strategies including surgical team hand and forearm antisepsis, strict sterile practices, gentle handling of tissues and the elimination of dead space at the surgical site, the application of a sterile dressing for a minimum of 24-48 hours, and changing any subsequent dressings using a sterile technique. Other strategies that have proven beneficial in lowering the rate of SSIs after hip and knee surgery include intraoperative lavage with dilute Betadine [17] and preoperatively addressing modifiable risk factors such as the patient's nutritional status, smoking status, and diabetic control, among others [18]. Despite these efforts, SSI prevention remains an important clinical challenge and demands innovative interventions.

Negative-pressure therapy (NPT) in the form of vacuum-assisted closure was first introduced in 1997 [19,20] and has been used effectively in a variety of clinical scenarios to treat acute and chronic open wounds. It is considered the standard of care for many types of open wounds. In an effort to decrease surgical site complications, several recent studies have reported lower rates of wound complications and SSIs using ciNPT on closed surgical incisions in orthopedic trauma [21-24], cardiothoracic surgery [25,26], vascular surgery [27], general surgery [28,29], plastic surgery [30], and obstetrics [31]. However, the use of closed-incision NPT (ciNPT) in preventing surgical site complications in arthroplasty patients undergoing revision hip and knee surgery has not been evaluated.

The purpose of this study was to assess the effect of ciNPT on the rate of wound complications, SSIs, and reoperations after revision hip and knee surgery. Our hypothesis was that ciNPT applied to these closed incisions would decrease the rate of surgical site complications compared with a sterile antimicrobial dressing (AMD) in these patients who are at relatively high risk for developing wound complications and SSIs.

Methods

A series of 141 consecutive hip and knee surgeries performed by the senior author (H.J.C.) between October 2012 and August 2015 were identified in patients who had undergone previous hip or knee surgery. Demographic, perioperative, and outcome data were collected using outpatient office notes, inpatient progress notes, operative reports, and anesthesia records. Three patients (2.1%) were lost to follow up before documentation of successful wound healing (minimum 30 days) and subsequently were excluded, leaving 138 patients (97.9%) for analysis. The cohort included patients undergoing conversion of previous hip surgery to THA (14), aseptic revision hip arthroplasty (32), aseptic revision knee arthroplasty (27), irrigation and debridement of an acute postoperative infection or hematoma (3), one-stage exchange for acute postoperative infection (2), explantation and placement of an antibiotic cement spacer for an infected joint arthroplasty (28), spacer removal and reimplantation of a previously infected joint arthroplasty (19), and open reduction and internal fixation of a periprosthetic fracture around a well-fixed hip or knee implant (13). Irrigation and debridement procedures that failed to adequately control deep infection were excluded from analysis, to remove the negative influence of persistent deep infection on wound healing. Surgical incisions were classified as clean (class I) or dirty/infected (class IV) as defined by the CDC [14].

Preoperative SSI prevention measures were standardized when possible. Patients undergoing elective surgery performed 5 days of preoperative skin preparation with 2% CHG wipes (Sage Cloths; Sage Products LLC, Cary, IL), whereas urgent cases received 1 day of preoperative skin preparation as an inpatient the evening before surgery. Elective cases also went through a preoperative nasal screening program and were decolonized with mupirocin ointment when nasal cultures were positive for *Staphylococcus aureus*. In the operating room, surgical sites were shaved using hair clippers when required, and the skin was prepped with 2% CHG (ChloraPrep; CareFusion, San Diego, CA). Preoperative antibiotics were administered within 60 minutes of incision, whereas postoperative antibiotics were stopped within 24 hours for aseptic cases but continued in patients undergoing revision for septic failure. At the conclusion of each surgical procedure, a dilute Betadine lavage was used to irrigate the joint according to published protocols [17]. All surgical incisions were closed primarily in a standard fashion using continuous barbed absorbable monofilament sutures for the fascia and subcutaneous layers. The skin was typically closed with a continuous absorbable barbed subcuticular monofilament suture; however, skin staples or nonabsorbable monofilament sutures placed using a vertical mattress technique were occasionally used at the senior author's discretion.

The standard postoperative dressing for patients undergoing open hip and knee surgery at our institution is a sterile AMD (AQUACEL Ag; ConvaTec, Greensboro, NC) and was used throughout the study period. This dressing has been shown to decrease the risk of acute PJI after total joint arthroplasty compared to dry gauze dressings [32]. The AMD was left in place for a minimum of 5 days unless it became saturated and required a premature dressing change.

The senior author began selectively using ciNPT in May 2014 for patients thought to be at particularly high risk for wound complications. No formal selection criteria were used at the time to assign patients ciNPT, and the decision was based on a subjective assessment by the senior author. Risk factors used to subjectively assess SSI risks included morbid obesity, multiple significant medical or social comorbidities, treatment of an infected joint arthroplasty, and a wound closure under tension. Indications for ciNPT grew as the study period progressed, based on a subjective positive response of those treated early (Fig. 1). The ciNPT dressing (Prevena Incision Management System; Kinetic Concepts, Inc, San Antonio, TX) was placed under sterile conditions over the closed surgical incision at the conclusion of the operative procedure, whereas the operative drapes were still in place (Fig. 2). The dressing was connected to a closed suction device set to provide 125 mmHg of continuous negative pressure. The initial sterile ciNPT dressing was left in place and not changed for a mean of 9.2 days (range, 6-14 days) before being discontinued. Length of stay was not affected by the use of ciNPT; if patients were otherwise stable for discharge before the fifth postoperative day, therapy was maintained for an additional 7 days at home or at the postdischarge rehabilitation facility with a portable negative-pressure pump connected to the original ciNPT dressing. Other than the use of ciNPT, nothing differed between the study and control groups.

Data on wound complications were collected through the first 90 days after the index procedure. Primary outcome measures included (1) incidence of general wound complications, (2) incidence of total SSIs, and (3) reoperation rate for wound complications. Secondary outcome measures included (4) incidence of superficial wound dehiscence, (5) incidence of superficial SSIs, and (6) incidence of deep SSIs. Wound complication was defined as any wound dehiscence, suture granuloma, prolonged drainage for >5 days, significant hematoma formation, or SSI that required postoperative interventions including unplanned office visits, topical application of antibiotic ointment, prescription for oral antibiotics, in-office wound debridement or removal of buried suture material, hematoma aspiration and drainage, or reoperation. SSIs were categorized based on CDC definitions [14,33], which define superficial and deep SSIs as occurring within 30 and 90 days of the index procedure, respectively. Multiple patients had more than one