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Closed incision negative pressure therapy decreases complications after periprosthetic fracture surgery around the hip and knee

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ABSTRACT

Introduction: Periprosthetic fractures (PPFXs) are becoming increasingly common following total hip arthroplasty (THA) and total knee arthroplasty (TKA). Patients sustaining PPFXs face considerable perioperative morbidity, with relatively increased rates of surgical site infection. We sought to evaluate the efficacy of closed-incision negative-pressure wound therapy (ciNPT) in decreasing perioperative wound complications following lower extremity periprosthetic fracture surgery.
Methods: We performed a retrospective review of 69 consecutive patients who underwent surgery to address lower extremity periprosthetic fractures around hip or knee implants performed over a 6.5-year period. The population was divided into two groups based on the surgical dressing used at the conclusion of the procedure: (1) a sterile, antimicrobial hydrofiber dressing, or (2) ciNPT. There were no baseline demographic differences between the two groups. Rates of wound complications, surgical site infection, and reoperation related to the surgical site were compared between groups. Continuous variables were analyzed using a student's *t*-test, and categorical variables using either chi-square or fisher's exact test.
Results: Patients treated with ciNPT developed fewer wound complications (4% vs. 35%; p = 0.002), fewer deep infections (0% vs. 25%; p = 0.004), and underwent fewer reoperations related to the surgical site (4% vs. 25%; p = 0.021) compared to patients treated with standard of care.
Conclusions: Our findings suggest that ciNPT may reduce wound complications, SSIs, and reoperations in patients undergoing lower extremity periprosthetic fracture surgery. This is the first study to investigate ciNPT as a treatment for periprosthetic fracture surgery, and has the potential to change the postoperative management of these patients.

Introduction

Periprosthetic fractures (PPFXs) represent an increasingly common failure mode following total hip arthroplasty (THA) and total knee arthroplasty (TKA), with a reported lifetime prevalence of up to 4.2% following THA and up to 2.5% following TKA [1]. Treatment of PPFXs accounts for approximately 6% of revision hip procedures [2–4] and 2–3% of revision knee procedures [3–5]. Presently, approximately 15,000 PPFXs are treated annually in the United States [1], however this number is expected to increase substantially as the revision burden grows with time [6].

Patients sustaining PPFXs face considerable perioperative morbidity, with mortality rates of 11–27% in the first year following surgery [1,7,8,9–11]. This risk may be related, in part, to the high risk of reoperation (12–33%) within the first year [1,13] [1,8912,13]. In this patient population, many of the reoperations result from problems with the surgical incision, with surgical site infection (SSI) rates reported to range between 9 and 26%. [1,8,13,14].

Closed-incision negative pressure therapy (ciNPT) has more than a decade of clinical evidence supporting a clear reduction in SSI rates and wound complications in high-risk surgical incisions [15]. Recent studies have demonstrated a potential benefit both in patients being treated for high-energy lower extremity trauma

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[16–19] and in patients undergoing revision hip and knee arthroplasty [20].

The purpose of this study was to assess the effect of ciNPT on the rate of incisional complications, deep SSI, and reoperations after PPFX surgery around the hip and knee, using a retrospective comparative cohort design. Our hypothesis was that ciNPT applied to these incisions would decrease the rate of surgical site complications compared with a standard dressing in these patients, who are at a relatively high risk for developing wound complications and infections.

Methods

Patient selection

A local administrative database was used to identify 69 consecutive patients undergoing operative management of a lower-extremity PPFX at a single institution between January 2010 and July 2016. One patient expired as an inpatient on postoperative day 17 and one patient was lost to follow-up prior to documentation of successful wound healing (minimum 30 days). These two patients were excluded, leaving 67 of 69 patients (97.1%) with appropriate clinical follow-up to be included in data analysis.

Surgeries were performed by one of four attending surgeons, who held a subspecialty practice either in orthopaedic traumatology (*author's initials blinded*) or adult hip and knee reconstruction (*author's initials blinded).* Demographic, perioperative, and outcome data not captured in the administrative database were collected using outpatient office notes, inpatient progress notes, operative reports, and anesthesia records. Study methodology was approved by our health system's Institutional Review Board.

The cohort included patients undergoing management of PPFXs of the acetabulum, femur, or tibia, either around a THA, TKA, or to address an inter-prosthetic fracture between a THA and TKA (Table 1). Procedures included open reduction and internal fixation (ORIF) with component retention, or revision of one or both components of a THA or TKA (Table 1). Surgical incisions were classified as clean (class I), clean-contaminated (class II), contaminated (class III), or dirty/infected (class IV) as defined by the CDC [21].

Perioperative management

Preoperative SSI prevention measures were standardized when possible. Institutional protocol for urgent cases is to receive one application of preoperative skin preparation with 2% CHG wipes (Sage® Cloths; Sage Products LLC, Cary, IL) as an inpatient prior to surgery. Cases performed beginning in 2016 went through a preoperative rapid *Staphylococcal* PCR nasal screening program and were decolonized with single-application povidone-iodine nasal preparation (3M™ Skin and Nasal Antiseptic; 3M™, St. Paul, MN) when PCR was positive for *Staphylococcus aureus*. This screening protocol was not in place for cases performed prior to 2016 (Fig. 1). In the operating theater, surgical sites were shaved using hair clippers when required, and skin was prepped with 2% CHG (ChloraPrep®; CareFusion, San Diego, CA). Preoperative antibiotics were administered within 60 min of incision, while postoperative antibiotics were stopped within 24 h. At the conclusion of each surgical procedure, a dilute povidone-iodine lavage was used to irrigate the joint according to published protocols for cases performed beginning in 2012 (Fig. 1) [22]. Surgical incisions were closed according to the preference of the treating physician, and methodology was not consistent.

The standard postoperative dressing for patients undergoing open orthopaedic surgery at our institution is a sterile antimicrobial dressing (AMD) (AQUACEL® Ag; Convatec, Greensboro, NC) and was used throughout the study period. This specific dressing has been shown to decrease the risk of deep infection following elective primary total joint arthroplasty [23]. Our protocol is to leave the AMD in place for a minimum of five days unless it becomes saturated and requires a premature dressing change.

Closed incision NPT became available for use at our institution in April 2014. Based on positive results seen in other patient cohorts [20], it was first applied to this PPFX population in October 2014. When both options were available, no specific criteria were used to decide between AMD and ciNPT dressings, and the choice was based on preference of the treating surgeon. The ciNPT dressing (Prevena™ Incision Management System; Kinetic Concepts, Inc, San Antonio, TX) was placed sterilely over the closed surgical incision at the conclusion of the operative procedure, with the operative drapes still in place (Fig. 2). The dressing was connected to a closed suction device programmed to provide 125 mm Hg of continuous negative pressure. On-label use of this device supports use up to 7 days; our practice was to maximize therapy duration as long as possible. Because this is a portable, disposable device that can transition with the patient, length of inpatient stay was not affected by the use of ciNPT (9.3 days for AMD vs. 8.5 days for ciNPT; p = 0.825). Other than the use of ciNPT, treatment protocols did not differ between the study and control groups.

Outcome

Data on wound complications and infections were collected through the first 90 days following the index procedure, to address any potential bias in the length of available follow-up between groups. Primary outcome measures included (1) incidence of general wound complications, (2) incidence of deep SSIs, and (3) reoperation rate for wound complications. Wound complications were defined as any wound dehiscence, suture granuloma, prolonged drainage greater than 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, [24] which define a deep SSI as occurring within 90 days of the index procedure. Multiple patients had more than one complication (eg, wound complication, deep SSI, and reoperation); in these patients, each of these complications was tabulated separately in the appropriate category.

Table 1
Baseline data regarding location and treatment choice for periprosthetic fractures.

Fracture Site		Major Procedure	
Acetabulum	4	ORIF Acetabular Fracture	1
Femur	60	Revision THA (Acetabular Component)	3
Femoral Shaft	43	Revision THA (Femoral Component)	22
Supracondylar Femur	15	Revision THA (Both Components)	10
Greater Trochanter	2	ORIF Greater Trochanteric Fracture	2
Proximal Tibia	3	ORIF Femoral Shaft Fracture	10
		ORIF Supracondylar Femur Fracture	6
Existing Arthroplasty		Retrograde Femoral IM Nail	5
THA	44	Revision TKA (Femoral Component)	1
TKA	15	Revision TKA (Both Components)	7
THA and TKA (Interprosthetic)	8	ORIF Proximal Tibia	0

THA = total hip arthroplasty; TKA = total knee arthroplasty; ORIF = open reduction and internal fixation; IM = intramedullary.

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