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Procrastination of Wound Drainage and Malnutrition Affect the Outcome of Joint Arthroplasty

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Abstract The association between wound drainage and subsequent periprosthetic infection is well known. However, the most appropriate treatment of wound drainage is not well understood. We retrospectively reviewed the records of 10,325 patients (11,785 procedures), among whom 300 patients (2.9%) developed persistent (greater than 48 hours postoperatively) wound drainage. Wound drainage stopped spontaneously between 2 and 4 days in 217 patients treated with local wound care and oral antibiotics. The remaining 83 patients (28%) underwent further surgery. A single débridement resulted in cessation of drainage without subsequent infection in 63 of 83 patients (76%), whereas 20 (24%) patients continued to drain and underwent additional treatment (repeat débridement, resection arthroplasty, or long-term antibiotics). Timing of surgery and the presence of malnutrition predicted failure of the first débridement. There were no differences between the success and failure groups with regard to all other examined parameters, including demographic or surgical factors.

Level of Evidence: Level III, prognostic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Periprosthetic infection remains one of the leading causes of morbidity after total hip and knee arthroplasty [4]. Reported rates of prolonged wound drainage range from 1.3% to 33% and likely reflect varied definitions and surveillance [8, 12]. Persistent wound drainage (greater than 48 hours postoperatively) has been identified as a contributing factor to the development of periprosthetic infection, with infection rates ranging from 1.3% to 50% [8, 9, 11–13]. Several studies suggest that with each day of prolonged wound drainage, there is an increased risk of infection [7, 9, 10].

The various treatment modalities of persistent drainage may include irrigation, débridement, polyethylene exchange, and parenteral antibiotics [12]. Most persistent wound drainage stops spontaneously and does not require surgical débridement [9]. However, it is believed that drainage persisting more than 5 to 7 days is unlikely to stop spontaneously [2]. Therefore, some studies have advocated surgical intervention for cases of persistent surgical site drainage [2, 11, 12]. The risk factors associated with prolonged surgical site discharge including morbid obesity, advanced age, rheumatoid arthritis, the use of low-molecular-weight heparin, and increased blood loss or drain output have been thoroughly investigated [6, 9, 14]. However, the literature contains little about which, if any, factors predict the likelihood of spontaneous cessation of drainage versus the need for surgical intervention. Furthermore, the timing of any needed surgery for best outcome is not well defined. We presumed the health status and comorbid state of the patient as well as surgical variables including blood loss and postoperative factors as anticoagulation may come into play and undermine the outcome.

Therefore, we endeavored to delineate the various patient risk factors predicting failure of further surgery in a patient with persistent drainage. Although a duration of 5 to 7 days of persistent drainage has been proposed as the threshold for surgical intervention [2], the optimal timing of surgical intervention requires further elucidation.

Materials and Methods

In 2000 we began a prospective cohort study of all patients undergoing a total hip or knee arthroplasty at our institution to investigate the outcomes and complications of these procedures. Here we retrospectively identified those patients with persistent postoperative drainage. The effect of the various confounding variables on the outcome of the surgical treatment of drainage was analyzed using a multivariate model. Using an institutional computerized database we identified 10,325 patients with 11,785 consecutive total hip and knee arthroplasty (including primary and revision procedures) performed between September 2000 and September 2005. Among the 10,325 patients with 11,785 arthroplasty, 300 developed persistent (greater than 48 hours) wound drainage that soaked through the postoperative dressings. All initial surgical procedures were elective and no patients displayed evidence of infection (serology, radiographic, and clinical manifestations) at the time of the index operation. No patients were seen specifically for this study. The minimum followup was 1 year for patients with persistent postoperative drainage without loss to followup. We obtained Institutional Review Board approval for the study.

All surgical procedures were performed in operating rooms equipped with vertical laminar air flow. All surgical personnel wore body exhaust suits. We administered antibiotic prophylaxis just before surgery and 24 hours postoperatively for all patients. The antibiotic of choice was a first-generation cephalosporin (cefazolin) or vancomycin for patients with proven penicillin allergy. The same surgical incision was utilized for the revision procedures. We applied a tourniquet during the primary and revision procedures of all knee arthroplasty with minimal blood loss. None of the initial surgical procedures were treated postoperatively with a drain.

The postoperative rehabilitation protocols were similar in all patients. Patients were routinely seen by the physical and occupational therapists as of the first postoperative day. CPM (continuous passive motion) is selectively used for our patients. Obese patients, revision cases (unless operated on for stiffness), bilateral procedures, patients with skin problems as well as patients with sensory epidural blocks were excluded from the use of CPM.

From the database and patient records we retrieved a number of surgical factors (joint operated, revision versus primary procedure, unilateral versus bilateral, estimated blood loss, operative time, blood transfusions), patient-specific factors (age, gender, body mass index, malnutrition [as determined by serum transferrin less than 200 mg/dL, serum albumin less than 3.5 g/dL, or total lymphocyte count less than 1500 per mm^3], American Society of Anesthesiology score, National Nosocomial Infectious Survival Score, anemia [hemoglobin less than 10 g/dL], history of smoking, other medical comorbidities [cardiovascular disease, inflammatory or autoimmune disease, malignancy, diabetes mellitus, and so on]), and pharmacologic factors (anticoagulation level, corticosteroid use). We also noted the timing of the surgery, length of hospital stay, and discharge disposition. The outcomes of surgical and nonsurgical treatment of persistent wound drainage were recorded. We defined surgical success as retention of prosthesis and failure as deep infection in patients who underwent excisional arthroplasty or had chronic suppressive antibiotics.

The surgical dressing was taken down on the first postoperative day and was evaluated daily by the attending physician and surgical residents. Patients with persistent wound drainage were treated according to an institutional protocol. We cleansed the surgical wounds twice daily with sterile saline solution followed by application of povidone-iodine solution. A sterile dressing was applied to wounds with persistent drainage and this was changed twice daily during routine wound care. We administered prophylactic oral antibiotics (cephalexin or clindamycin) while wound drainage was present.

We performed irrigation and débridement in the operating room for patients with drainage that persisted and soaked the gauze dressing despite local wound care and oral antibiotics. Tissue cultures were obtained at the time of surgery. Deep cultures (around the prosthesis) were obtained when the deep fascia was opened and had not sealed at the time of surgery. Some patients failed to undergo surgical intervention within the recommended one week interval from the start of drainage due to uncontrollable factors including patient preference in deferring surgery to a later date and the development of postoperative complications such as delayed wound healing and skin breakdown that was treated nonoperatively. A few of the patients developed their persistent drainage at rehabilitation facilities after discharge, which made implementing our institution's policy of early surgical intervention very arduous.

We compared proportions of the categorical variables using chi square and Fisher exact text. The Fisher Exact Test was used in the analysis of categorical data where sample or cell sizes were small. Continuous variables were

compared using the T statistics (parametric) and Wilcoxon test (nonparametric). The t-test was used based on the assumption that the variables were independent and were roughly normally distributed. However, if the sample size was too small, we used nonparametric tests (Wilcoxon test). Stepwise logistic regression adjusted analysis was performed to determine the predictors of failure of irrigation and débridement in treating patients with refractory wound drainage after total hip or knee arthroplasty. The regression analysis assessed all patient specific and surgery related factors listed above. All statistical analysis was performed using SAS version 9.1 (SAS Institute Inc, Cary, NC). All analysis were two-tailed.

Results

The majority (217 [72%]) of patients were treated nonoperatively with local wound care and prophylactic oral antibiotics for 2 to 4 days. These patients had uneventful resolution of wound drainage, required no further treatment, and were infection-free at one year followup. The successful group included 106 men and 111 women with an average age of 64 and BMI of 31. Eighty-three patients (28%) (57 primary and 26 revisions) underwent surgical débridement. Débridement alone with retention of prosthesis was successful in treatment of persistent drainage in 63 patients while it failed in the remaining 20 (Table 1). Eleven of the 20 patients from the unsuccessful group underwent subsequent two-stage exchange arthroplasty. Five patients had resection arthroplasty but, as a result of ill health, could not be reimplanted. Three additional patients who underwent irrigation and débridement with placement of temporary antibiotic-laden prostheses (PROSTALAC, DePuy, Warsaw, Indiana) had not undergone any further surgery. One patient, because of extreme poor health, remained on long-term antibiotic suppressive therapy.

A comparative analysis of patient specific risk factors among the "success" and "failure" groups revealed that treatment in a substantially greater percentage of malnourished patients failed (odds ratio, 18.29; $p = 0.002$). The proportion of patients with malnutrition at the time of irrigation and débridement was higher ($p < 0.0003$) in the failure group (35%) than in the success group (5%). There was no difference between the "success" and the "failure" groups with regard to demographic factors (age, gender, body mass index), type of index surgical procedure (hip versus knee arthroplasty, primary versus revision, unilateral versus bilateral), or distribution of medical comorbidities (Table 1). The preoperative and postoperative values for some important laboratory tests (total white blood cell count, hemoglobin, mean international normalized ratio, prothrombin time, blood urea nitrogen, and creatinine) were also similar between the two groups. Surgical related factors including operative time, estimated blood loss, and postoperative transfusion were similar for the two groups as well (Table 1). Positive bacterial cultures obtained from deep (periprosthetic) tissue were more common in the failure group (17 of 20 [85%]) than in the success group (11 of 63 [17%]). The mean number of hospital readmissions for any etiology including persistent drainage, infection, and mechanical failure was higher ($p < 0.001$) in the failure group compared with the success group (Table 2).

The mean interval from the start of drainage to performing irrigation and débridement was prolonged ($p = 0.03$) in the group that later became infected after surgical treatment (5 versus 10 days). Similarly, the time interval between index arthroplasty and incision and débridement was notably prolonged in patients whose treatment failed ($p < 0.009$). Patients in the success group underwent surgical débridement of the draining wound at a mean of 14 days postoperatively (range, 4–32 days), whereas the mean time to surgical débridement in the failure group was far greater at 22 days (range, 2–37 days) ($p < 0.009$). Multivariate analysis revealed that procrastination in surgical intervention of persistent drainage is a major risk factor for poor outcome (odds ratio, 1.15; $p = 0.02$).

Table 1. Nonsignificant variables in the comparison of successfully treated and failed groups

Variables	Success (63)	Failure (20)	p
Age (years)	65	64	0.74
Gender (men/women)	57%/43%	65%/35%	0.54
Body mass index (kg/m^2)	32	36	0.11
Joint (knee/hip)	70%/30%	70%/30%	0.99
Primary/revision	67%/33%	75%/25%	0.49
Estimated blood loss (mL)	373	366	0.37
Operative time (minutes)	88	83	0.56
Postoperative transfusion	40%	30%	0.43
Mean postoperative international normalized ratio	1.36	1.34	0.66
Diabetes mellitus	13%	25%	0.19
Heart disease	17%	15%	0.80
Lung disease	13%	21%	0.42

Table 2. Significant risk factors for treatment failure

Variables	Success (63)	Failure (20)	p
Time from arthroplasty to débridement (days)	14	22	0.009
Time from wound drainage to débridement (days)	5	10	0.03
Number of readmissions (mean)	1	2	0.001
Malnutrition	5%	35%	0.0003

Discussion

Persistent postoperative drainage after total hip and knee arthroplasty is a potentially ominous finding. However, the literature has no clear suggestions for characteristics that might predict a need for surgery for persistent drainage or the timing of surgery for the best outcome. We presumed the health status and comorbid state of the patient as well as surgical variables including blood loss and postoperative factors as anticoagulation may come into play and undermine the outcome. Therefore, we identified various patient risk factors predicting failure of further surgery in a patient with persistent drainage.

We encountered some inherent limitations in our study when clarifying the questions raised above. Although our database is prospective in nature, the collection of information was retrospective, so some data may have escaped detection. Because of the relatively small number of patients in the study in general, and the "failure" group in particular, some confounding variables may have been masked. The time interval from the start of drainage and surgical intervention varied according to patient preference and was under the effect of other postoperative complications that developed. Although a randomized trial would have been ideal, the ethical justification of such a study is lacking. Although all patients in our arthroplasty database received prophylactic antibiotics prior to surgery, we were unable to determine the exact time interval at which the antibiotic was given which may have produced some biases. However, the limitations of our study do not detract from the importance of our findings.

One study reported patients who had 5 days or more of postoperative wound drainage were 12.5 times more likely to develop infection than those without drainage [10]. Each day of prolonged wound drainage reportedly increases the risk of wound infection by 42% in hip arthroplasty and 29% in knee arthroplasty [9]. However, the timing of surgical intervention for persistent drainage that affords an optimal success rate remains ill-defined.

Our data suggest there is an improved chance of successful treatment of persistent wound drainage after total joint arthroplasty if surgical débridement is performed early on. It has been suggested that persistent drainage for more than 5 to 7 days is unlikely to stop and débridement will be necessary [2]. Weiss and Krackow [12] advocated surgery at 12 days, but noted that cultures at that time were positive in 25% of patients. We found patients who underwent débridement at a mean of 5 days following the onset of drainage were more likely to be infection free at one year postoperatively compared to patients who underwent débridement at a delayed time (mean, 10 days).

In addition to the timing of surgical débridement, malnutrition was associated with failure of irrigation and débridement to treat persistent postoperative wound drainage. Previous reports have implicated malnutrition in increasing the risk of wound healing problems after arthroplasty [1, 3, 5]. Our data confirmed that malnourished patients (serum transferrin less than 200 mg/dL, serum albumin less than 3.5 g/dL, or total lymphocyte count less than 1500/mm^3) undergoing total joint arthroplasty are more likely to develop deep infection and require further treatment after irrigation and débridement.

Based on these findings, we recommend early (within 7 days) surgery for persistent wound drainage in general, and particularly for those with malnutrition. The importance of nutritional parameters on the outcome of persistent wound drainage has prompted us to seek nutritional consultation and reversal of malnutrition for any patients with drainage longer than 48 hours after total joint arthroplasty.

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