Arthroplasty Today 5 (2019) 329–333

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Original research

The risk factors and an evidence-based protocol for the management of persistent wound drainage after total hip and knee arthroplasty

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ARTICLE INFO

Article history:
Received 7 October 2018
Received in revised form
3 May 2019
Accepted 22 May 2019
Available online 29 June 2019

Keywords:
Total joint arthroplasty
Complications
Persistent wound drainage
Management
Risk factors

ABSTRACT

Background: Persistent wound drainage (PWD) is one of the major risk factors for periprosthetic joint infections (PJIs), arguably the most dreaded complication after total joint arthroplasty (TJA). The aim of this study was to identify the risk factors for PWD and provide a stepwise management protocol for it.
Methods: A retrospective review of 4873 TJAs was performed. After determining patients with PWD, a logistic regression model was designed to identify the risk factors using Charlson and Elixhauser co-morbidity indexes. Finally, the protocol that was instituted for the management of PWD and its success rate was presented.
Results: The prevalence of PWD was 6.2% (302 of 4873). Of these, 196 did not require any surgical interventions, and drainage stopped with local wound care. 106 patients required surgical intervention, of which, 64 underwent superficial irrigation and debridement and 42 underwent deep irrigation and debridement with modular components exchange. Patients with PWD had significantly higher rates of PJI (odds ratio [OR]: 16.9; 95% confidence interval [CI]: 9.1-31.6). Risks factors were diabetes (OR: 21.2; 95% CI: 12.8-25.1), morbid obesity (OR: 17.3; 95% CI: 14.7-21.5), rheumatoid arthritis (OR: 14.2; 95% CI: 11.7-16.5), chronic alcohol use (OR: 4.3; 95% CI: 2.3-6.1), hypothyroidism (OR: 2.8; 95% CI: 1.3-4.2), and female gender (OR: 1.9; 95% CI: 1.1-2.2).
Conclusions: Several modifiable risk factors of PWD were identified. Surgeons must be cognizant of these comorbidities and optimize patients' general health before an elective TJA. Our results demonstrated that PWD ceased in about 65% of the patients with local wound care measures alone. Patients with PWD were at substantially higher risk for PJI.

Introduction

Periprosthetic joint infection (PJI) is one of the most dreaded complications after total joint arthroplasty (TJA) [1]. Although PJI is not the most common complication, it is the most common cause for revision within 2 years for total knee arthroplasty (TKA) [1-4]. Reducing the risk of developing a PJI after TJA has been the motivation of countless studies ranging from preoperative protocol to intraoperative and postoperative techniques. A major risk factor for PJI is persistent wound drainage (PWD) [5-8]. Draining wounds are a relatively common and challenging problem, with an incidence of up to 14% of all total hip arthroplasty (THA) and TKA procedures [9,10]. The subsequent rate of PJI after persistently draining wounds has ranged from 1.3% to 50% [11-15]. Despite this potentially high rate of infection, there is no unified protocol for management of these wounds. In addition, identifying risk factors for PWD may identify proactive measures that can be taken to prevent this complication.

Numerous definitions have been introduced for persistent drainage after THA and TKA, most of which are different in duration

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which-may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to https://doi.org/10.1016/j.artd.2019.05.003.

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https://doi.org/10.1016/j.artd.2019.05.003

and amount of drainage. The 2013 International Consensus Meeting on PJI provided a definition for PWD. The work group recommended that substantial drainage (greater than 2 × 2 cm area of gauze) from a wound beyond 72 hours should be considered abnormal [5]. In most cases, local wound treatments are successful in halting the drainage. However, it has been reported that draining wounds are unlikely to cease after 5-7 days [16]. Thus, general consensus has been that drainage beyond 5-7 days is an indication for surgical intervention [16-18].

Conservative management of the early draining wound can include pharmacological and dressing changes. Negative pressure wound therapy has gained a significant attention for management of draining wounds in the recent years. Negative pressure wound therapy has been touted to reduce retrograde flow into the wound and aid in wound healing [19,20]. However, more recent studies have put this benefit into question for standard TJAs and have highlighted possible risks such as blistering [21-23]. Other reported methods that have been successful in stopping PWD include pausing anticoagulant agents, employing compression dressings, and reducing joint motion [13,24]. Current literature strongly recommends against administration of antibiotics during early stages in patients with continued drainage as it can compromise subsequent laboratory evaluations and has not been shown to decrease the risks of PJI development [17,25,26].

With the lack of consensus on the management of PWD after THA and TKA, the aim of this study is to provide an evidence-based management protocol and assess the outcomes of this protocol. This study also aimed to determine the rate of PWD after TJA, as well as the relationship between PJI and PWD. Moreover, we sought to investigate the risk factors that can lead to higher rates of wound drainage after THA and TKA.

Material and methods

Upon institutional review board approval, we conducted a retrospective single institutional study and reviewed all 4873 primary TJAs (1218 THAs and 3655 TKAs) that were performed between 2008 and 2015. There were no exclusion criteria. Due to the lack of an International Classification of Diseases, Ninth Revision (ICD-9) code for wound drainage, our institutional database was queried for key words such as drainage, draining, outflow, oozing, leak, discharge, exudate, and wound complication. Charts, which contained the aforementioned keywords, were then manually reviewed. Patients with wound drainage for longer than 48 hours were identified. The definition of PWD in this study was drainage greater than 2 cm × 2 cm after 48 hours postoperatively. All TJA patients who underwent subsequent irrigation and debridement (I&D), revision arthroplasty, or developed PJI within 1 year were identified for this study. Three hundred two patients with PWD were identified. The demographics are presented in Table 1. All 302 patients in the study with PWD were followed for a minimum of 1 year.

To identify risk factors for PWD, the Charlson and Elixhauser comorbidity indexes, which track ICD-9 codes, were used to identify comorbidities. Patient demographic data were also obtained from the indexes and chart review. Acute PJI was identified based on the 2011 Musculoskeletal Infection Society criteria within 90 days postoperatively from index procedure [27]. A multivariate logistic regression model was designed to calculate the odds ratios (ORs) for each of these comorbidities and demographical items.

The management protocol consists of 2 main steps, nonoperative and operative. Patients with draining wounds were initially treated with nonoperative measures based on studies referenced above, which included suspension of anticoagulation, local wound care measures such as pressure bandages, frequent dressing changes, and reducing knee motion for TKA patients [13,27]. These conservative changes were implemented to allow the wound to rest temporarily. If drainage lasted longer than 7 days despite local wound care management, an I&D was performed [16-18]. Duration of drainage prior to surgical intervention varied slightly depending on severity of drainage, operating room and surgeon availability, and interval improvement. Based on intraoperative findings, a superficial I&D (ie, for a suture abscess) or deep I&D (ie, for drainage deep to fascia) was performed. If a superficial I&D was performed, the fascia was not breached. If a deep I&D was performed, all modular components were also exchanged and synovectomy was performed (Fig. 1). The anticoagulation agents were restarted after the second surgery (I&D) in all the patients.

Statistical analysis

Standard statistics were used to present the descriptive data. Chi-squared tests were used to compare the incidences. An alpha level of 0.05 was used to determine statistical significance. A multivariate regression model was used to analyze the risk factors associated with PWD. All the analyses were performed using R 3.1 (R Foundation for Statistical Computing, Vienna, Austria). The "survey" package for R was used to derive estimates of means, medians, standard deviations, standard errors, rates, and confidence intervals (CIs).

Results

Persistent wound drainage was found in 6.2% (302 of 4873) of all TJAs. Of these patients, 196 did not require any surgical interventions and drainage stopped with local wound care. One hundred six patients required surgical intervention, of which 64 underwent superficial I&D and 42 underwent deep I&D with modular components exchange (Fig. 2). There was no statistical difference in the demographics of the patients who required surgical intervention compared to those who ceased to drain without any surgical intervention.

Forty-eight of the 302 patients who had PWD (15.9%) developed PJI within 1 year of their surgery. Seventeen of the 64 patients who underwent a superficial I&D developed PJI, with a 26.6% rate of PJI after superficial I&D. Thirty-one of the 42 patients who underwent a deep I&D with modular exchange developed PJI, with a 73.8% rate of PJI after deep I&D. Of note, none of the patients who stopped drainage with nonoperative measures developed PJI within 1 year of the index surgery. Compared to those patients without wound drainage, the TJAs complicated by wound drainage demonstrated an OR of 16.9 (95% CI 9.1-31.6) for developing PJI. These patients also had an OR of 18.0 (95% CI 11.3-28.7) for undergoing a subsequent surgery, including I&Ds and revisions.

Risks factors for developing PWD before any intervention were found to include diabetes (OR 21.2, 95% CI 12.8-25.1), morbid obesity (OR 17.3, 95% CI 14.7-21.5), rheumatoid arthritis (OR 14.2, 95% CI 11.7-16.5), chronic alcohol use (OR 4.3, 95% CI 2.3-6.1), hypothyroidism (OR 2.8, 95% CI 1.3-4.2), and female gender (OR 1.9, 95% CI 1.1-2.2) (Table 2). Interestingly, TKA was also a risk factor for

Table 1
Demographics.

Procedure	Total hip arthroplasty (N = 1218)	Total knee arthroplasty (N = 3655)	*P*-value
Gender	743 female/475 male	1971 female/1684 male	<.05
Age (y)[a]	65.3 ± 21.2	63.7 ± 33.1	.1137
Body mass index (kg/m^2)[a]	44.1 ± 5.3	43.4 ± 7.1	.0016

[a] Variables are presented as mean ± standard deviation.

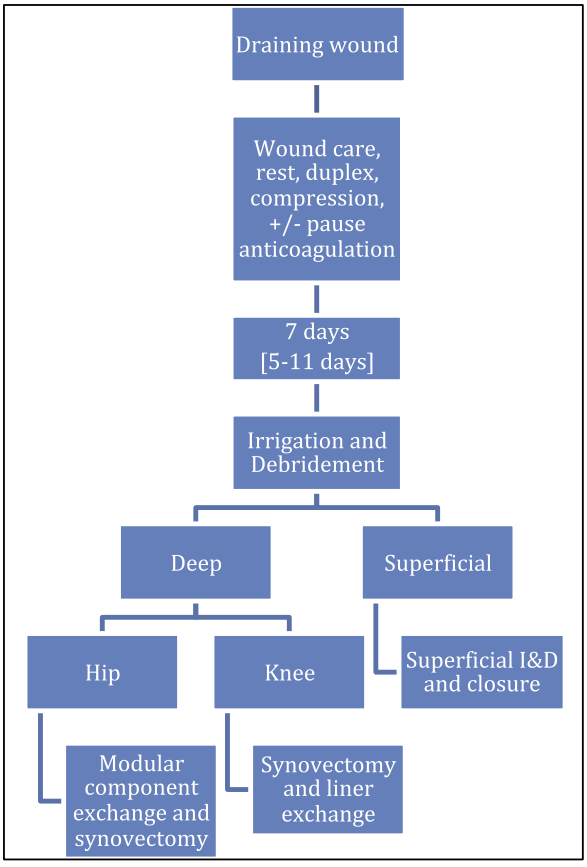

Figure 1. Protocol for management of persistent wound drainage in TJA.

developing PWD (OR 1.4, 95% CI 1.1-1.6). Patients with morbid obesity were found to have increased risk of prolonged drainage in THA ($P = .005$), but not in TKA ($P = .681$). The occurrence of wound drainage resulted in significantly longer hospital stays in both THA and TKA ($P < .005$) and significantly higher rates of PJI (OR 16.9, 95% CI 9.1-31.6). Finally, in 2014, our institutional anticoagulation protocol changed from warfarin to aspirin for most TJA patients. The rate of wound drainage significantly dropped after this time point from 6.3% to 3.1% ($P < .001$).

Discussion

Few studies have explored the independent risk factors for developing PWD after TJA. This study investigated the risk factors, both modifiable and nonmodifiable, that may lead to development of PWD, as well as a management protocol for treating this complication. Several risk factors were identified in this study that contributed to the development of wound drainage after TJA. The extent that some of these risk factors contribute is rather impressive and is consistent with previous studies [28]. Diabetes was found to have an OR of 21.2 for having PWD and morbid obesity had an OR of 17.3. Morbid obesity increased the risk of wound drainage in THA, but not TKA, which can likely be attributed to an increased amount of subcutaneous adipose tissue around the hip compared to around the knee in these patients. These risks may not be completely modifiable but can be reduced with proper medical treatment and perioperative management [29]. Nonmodifiable risk factors included a higher OR for TKA compared to THA, as well as female gender.

An interesting finding of this study was the decrease in the rate of PWD after the switch from warfarin to aspirin for deep vein thrombosis prophylaxis for most patients. The rate dropped from 6.3% to 3.1%. This correlates with several recent studies showing decreased complications and equivalent efficacy of aspirin therapy compared to traditional warfarin therapy. Aspirin has not been shown to increase the risk of deep vein thrombosis or pulmonary embolism after a TJA compared to warfarin [30-32]. Aspirin is also more predictable in its anticoagulant effects, while warfarin often does not reach therapeutic levels until after the patient has been discharged home [33]. Longer hospital stays were also found to be a result of persistently draining wounds, which can delay rehabilitation and increase morbidity and cost.

The management of persistent drainage has had a spectrum of recommendations, many of which are based on limited data. This study intended to evaluate a large sample of TJAs to determine the overall drainage rate and associated outcomes, as well as to provide an evidence-based guideline for management. The clinical success of our management guidelines validates similar published guidelines based on literature review that have been recently published [24,34].

This study evaluated a large patient group from a single institutional database using ICD-9. This contains some inherent limitations in regards to variability as well as limited data available

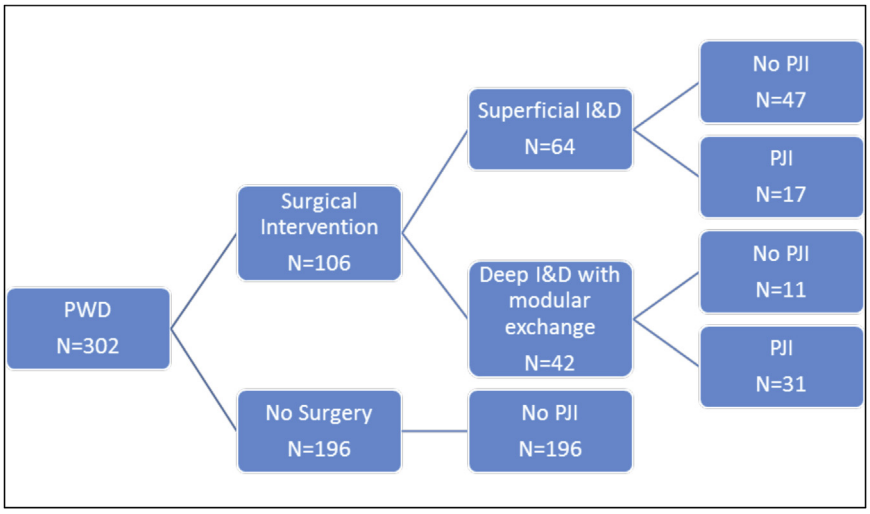

Figure 2. Breakdown of infection outcome in patients with persistent wound drainage.

Table 2
Risk factors for persistent wound drainage.

Comorbidity/demographics	Odds ratio	95% Confidence interval
Diabetes	21.2	12.8-25.1
Morbid obesity	17.3	14.7-21.5
Rheumatoid arthritis	14.2	11.7-16.5
Chronic alcohol use	4.3	2.3-6.1
Hypothyroidism	2.8	1.3-4.2
Female gender	1.9	1.1-2.2
Total knee arthroplasty	1.4	1.1-1.6

from ICD-9 databases. Since there was no ICD-9 code for wound drainage, a keyword chart search was required for identifying patients. This could result in under-reported occurrences of wound drainage. This study also did not identify the type of wound closure, nor the specific wound care techniques utilized. The introduced protocol in this study has been in place at our institution for a long time and surgeons have been coherent with this protocol for management of PWDs. However, there might be very few cases that were not managed exactly per protocol and we were not able to identify them in this study. Finally, if a patient was treated at an outside facility for subsequent drainage or infection, this would not be included in this study's analysis.

This study demonstrated the incidence of PWD (6.2%) and subsequent rate of PJI (15.9%) that are consistent with multiple other studies. Previously reported wound drainage rates ranged from 2.9% to 14% [10,11]. Other studies have shown rate of PJI after PWD as high as 50% [8,12,15]. Another study by Patel showed that the risk of infection with wound drainage increased 42% daily for THA and 29% daily for TKA [14]. A 26.6% rate of PJI in those patients who underwent a superficial I&D and a 73.8% rate of PJI in patients who underwent a deep I&D was noteworthy in our study. The results of this study add to the body of literature that shows PWD represents a significant risk for subsequent PJI.

Our wound drainage management protocol successfully treated 65% of these patients nonoperatively. Using local wound care, discretionary pausing of anticoagulation, and reducing range of motion of TKA, we were able to avoid more invasive management. Those that continued to have wound drainage after approximately 7 days were then subject to I&D with possible component exchange. The protocol was used as a guide for the surgeons included in the study and was adhered to as closely as possible. Minimal variability in surgical timing occurred based on severity of drainage, operating room and surgeon availability, and interval improvement of drainage. Jaberi et al successfully treated PWD in a majority of patients and also recommended surgical debridement by day 7 postoperatively to reduce infection risk [6,10]. A 20-year surveillance study by Saleh et al also found that the rate of infection increases by 12.7 times after 5 days of PWD [19]. All of our PJI occurrences were solely from the operative group, signifying that a 7-day time limit for conservative care is appropriate for treatment of PWD.

Conclusions

Wound drainage represents a common and challenging problem after TJA. This study isolated several patient comorbidities that increase the risk for wound drainage and subsequently the risk for PJI. To mitigate infection risk, modifiable risk factors should be optimized prior to surgery including hemoglobin A1c, weight loss, and decreased alcohol intake. An additional finding included the decreased rate of wound drainage with the use of aspirin for anticoagulation rather than warfarin. In order to minimize the risk of PJI after development of PWD, our institution developed an evidenced-based management protocol. This protocol was based on numerous evidence-based studies as well as our own personal management techniques of this problem. Using this protocol, we were able to successfully manage PWD with nonsurgical intervention in 65% of our patients. Most importantly, PJI was not diagnosed within the first year in any of the patients with PWD that was ceased with conservative measures by day 7. Aspirin also reduce the incidence of PWD by over 50%. Our management protocol is both simple and provides an effective system to manage PWD, while reducing the risk of PJI.

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