

## Original Article

# Determining the relation between total knee arthroplasty surgery site drainage in two weeks after surgery with periprosthetic joint infection (PJI) in two years

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**Abstract:** Background: Prosthetic joint infection (PJI) is a devastating complication in total knee arthroplasty (TKA) surgeries and prompt diagnosis and treatment are vital; however, no study has been conducted to determine the relationship between characteristics and duration of surgical site discharge and PJI. Methods: This is a longitudinal observational study that was performed at Al-Zahra and Kashani and Sadi university hospitals from 2017 until 2019. A total of 961 elective TKA were performed on 850 consecutive patients. Patients were followed up for two years after surgery. Data regarding the occurrence of discharges, types of discharges, duration of discharges, the incidence of PJI and superficial infections were collected. Results: The rate of superficial and prosthetic joint infection was 0.3% and 0.3%. Patients with infections (either PJI or superficial) had a longer duration of discharge (14.6 days and 13.3 days in PJI and superficial infections respectively, compared to 7.7 days in all of the study population); Bloody-purulent discharge was associated with the development of prosthetic and superficial infections. Conclusion: Bloody purulent discharge reaching seven days postsurgical in TKA patients is highly suggestive of an underlying infection (PJI or superficial infection) but type and duration of discharge could not be used to differentiate between PJI and superficial infection. Other risk factors for PJI or superficial infection include women's gender, longer surgical duration, longer hospitalization and longer discharge duration.

**Keywords:** Total knee arthroplasty, drainage, periprosthetic joint infection, infection

## Introduction

Total knee arthroplasty (TKA) is one of the common orthopedic surgeries. In TKA, the articular surface of the femur and tibia is removed from the knee joint and replaced with an implant [1]. The goal of this surgery is to eliminate knee pain, restore the desired range of motion in the knee joint and correct deformities created in the knee [2]. Obtaining the desired range of motion in the knee joint and correcting the deformations created in the knee is another use of the artificial knee joint [3].

One of the most common complications of TKA is infection. Periprosthetic joint infections (PJI) remain one of the most dramatic complications of TKA surgery affecting between 0.5% and 2% of patients, therefore prompt diagnosis and management are important keys for preventing

excess morbidity and disease burden [4, 5]. Postponement of PJI treatment can lead to treatment failure and subsequent surgeries at the same body site. Surgical site discharge can be caused by hematomas, superficial infections or PJIs; thus, differentiating the cause of discharge to make a timely diagnose of PJI is of high value [6].

Although due to the use of new antibiotics as well as the use of prophylactic antibiotics before surgery, the prevalence of postoperative infection has decreased to about 1%, it is still an important complication of this surgery [7]. In this regard, several studies and treatment strategies have been used, the most important of which is the use of antibiotics.

Using a drain after surgery can help prevent the formation of hematomas and, as a result, infec-

tion by helping the discharge from the wound. Theoretically, the use of drains not only helps reduce the risk of infection and hematoma formation but also reduces the patient's postoperative pain by draining the wound discharge and reducing the pressure inside it, as well as the need to change the bandages [8, 9]. However, previous studies have reported sparse results and reported a higher chance of developing wound-related problems in patients with and without the same drain [10].

To date, few studies have been conducted in this area and very few studies have been conducted on the effect of drainage on septic arthritis in patients undergoing TKA. The novelty of this study is that for the first time in Iran, we investigated the effect of using a drain and its relationship with PJI after 2 years of surgery.

### Methods and material

#### *Study design*

This is a longitudinal observational study that was performed at Al-Zahra and Kashani and Sadi university hospitals from 2017 until 2019. The current study was conducted on patients undergoing TKA. The study protocol was approved by the Research Committee of Isfahan University of Medical Sciences and the Ethics committee has confirmed it.

#### *Inclusion and exclusion criteria*

Inclusion criteria were age above 18 years, patient's candidates for TKA, residents of Isfahan city, undergoing TKA from 2017 until 2019 and signing the informed consent to participate in this study. Exclusion criteria were incomplete medical records, smoking, addiction, previous surgeries on limbs, traumatic events within the follow-up period, past medical diseases that increase the risks of infections and inappropriate follow-up visits and history of any former skin diseases such as psoriasis.

#### *Study population*

The study population was gathered using simple sampling from all TKA candidates. A total of 961 elective TKA were performed on 850 consecutive patients. The patients were candidates for TKA with end-stage knee damage

requiring arthroplasty. Demographic data of all patients including gender and age were collected.

#### *Joint replacement*

By injecting the anesthetic into the spinal epidural space, the surgeon made an incision of 20 to 25 cm in front of the knee. The damaged part of the joint was removed from the surface of the femur and tibia, and then the surfaces were shaped to be able to hold a metal or plastic prosthesis, then the implant was replaced.

Parts of the knee implant are made of metal and parts of the plastic are very durable. The prosthetic components are usually attached to the bed of the tibia and femur using bone cement (polymethylmethacrylate). After proper placement and adjustment, the attached artificial parts formed a joint that depends on the ligaments and surrounding muscles for function and stability. At the end of the process, the space created by the suture was sewn and placed on the dressing area.

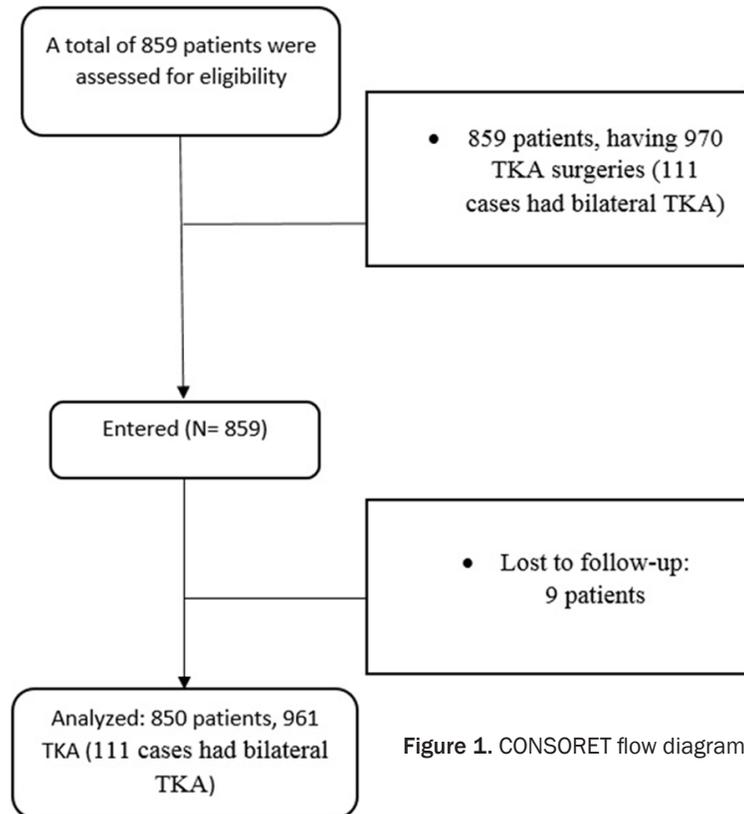
#### *Visits and interventions*

Three weeks before the surgeries, a preoperative visit was carried out to diagnose and completely treat any possible infectious sites. Modern operation theaters (using vertical laminar airflow and under general anesthesia) were used to perform the surgeries. All patients received one dose of intravenous Cefazolin thirty minutes before surgery. Simultaneous bilateral knee arthroplasty was performed in 111 cases (11%). Other patients underwent unilateral TKA.

For all patients, a suction drain was left in the joint and kept for 48 hours after the operation. Any signs of infection including erythema, warmth, swelling, or tenderness and the type and duration of discharge were recorded.

After removal of suction drain, in case of discharge more than one-week (7<sup>th</sup>-day post-operation), smear and culture from wound discharge were carried out. In case discharge is associated with the latter signs of infection arthrocentesis was performed to obtain the synovial fluid sample for smear and culture and appropriate intravenous medical treatment was offered. If the discharge persists despite medical treatment, a second wound smear and culture and

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All patients were followed-up for two years. Any patient with a surgical procedure on the operated joint for PJI treatment (including revision arthroplasty) (n=3) or Death (n=0) was considered to reach the endpoint of follow up and no further follow-up was considered for them.

### Data analysis

Data were analyzed using SPSS version 16.0 (Chicago, Illinois, USA). Kolmogorov-Smirnov. Levene's test was employed to check the normality and homoscedasticity of the data, respectively. To understand the correlation matrix among variables Pearson correlation was used. The level of significance for all analyses was set at  $P < 0.05$ . All data are presented as mean  $\pm$  standard error.

synovial fluid arthrocentesis were obtained and surgical drainage and polyethylene exchange was performed.

All patients were recalled and visited two weeks after surgery and in case of discharge, were treated as mentioned above and any signs and symptoms of infection were recorded. All patients were followed-up two years after surgery using the files of the local hospital patient database. Information regarding readmission to either of the operating hospitals in the district area was obtained from the administrative patient database of the hospitals and reviewed manually to record information more precisely.

### Data collection

The incidence of PJI within two years after TKA was considered as the primary outcome. CDC criteria were considered as the reference definition for PJI (12). Superficial wound infections (infections lying in epidermis, dermis and subcutaneous layer according to CDC classification) and those restricted to muscle or fascia but not evading into the joint cavity (deep wound infections) are referred to as superficial infections (13).

## Results

### Study population

A total number of 970 TKA surgeries in 859 patients were followed. Nine patients were lost due to the lack of proper follow-up visits. Data of 961 TKA in 850 patients were analyzed. The CONSORT flow chart is indicated in **Figure 1**. The study population consisted of 730 women (84.9%) and 129 men (15.1%). The mean age of patients was  $68.09 \pm 0.20$  years. Our analysis also showed that the mean duration of hospitalization was  $3.92 \pm 0.01$  days. These data are summarized in **Table 1**.

### Incidence of PJI

12.7% of TKA surgeries had discharges with a mean duration of  $13 \pm 0.011$  days. Within 2 years of follow-up, 3 PJIs and 3 surface infections were encountered. The two-year incidence of both PJI and the surgical site superficial infections were 0.3% (totally 0.6%).

There was a positive relationship between duration of discharge and the occurrence of both superficial infection and PJI. The mean dis-

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**Table 1.** Demographic information of the study population

Variable	Amount
Gender (N (%))	Male 129 (15.1%)
	Female 730 (84.9%)
Age (mean $\pm$ SD) (year)	68.09 $\pm$ 0.20
Duration of hospitalization (mean $\pm$ SD) (day)	3.92 $\pm$ 0.01

charge duration was 14.6 and 13.3 days in PJI and superficial wound infection patients respectively, compared to 7.7 days in all of the patients.

Type and duration of discharge, hospital stay duration, culture result and demographic data of patients with surface infections and PJIs are indicated in **Table 2**.

### *Correlations with PJI*

Based on our results, a significant relationship between the type of discharge and PJI occurrence was found ( $P < 0.05$ ). As mentioned, wound discharge was encountered in 122 patients (12.7%) of whom there was 1 transudate type (0.008%), 7 bloody-purulent type (0.57%), 1 purulent type (0.008%) and 113 bloody type (0.92%). We showed that 6 out of 7 patients with bloody-purulent discharges developed infections (3 of them superficial and 3 of them PJI infections and none of them had a concomitant PJI and superficial wound infection). None of the patients with transudate discharge or exclusively bloody discharge developed superficial wound infections or PJI.

The correlation matrix between parameters is shown in **Table 3**. PJI occurrence was significantly higher in women than in men ( $P = 0.006$ ). There were significantly longer hospital stays in patients with discharge. The duration of discharge had a significant positive relation to both PJI and superficial wound infection occurrences ( $P = 0.001$ ).

### *Follow-up*

All patients with PJI received appropriate intravenous antibiotic therapy and operative intervention. Debridement could not salvage any of the patients and the infected prosthesis was removed. During the study, no limb amputation or death caused by infection was observed.

## **Discussion**

This study examines the relationship between type and duration of discharge with PJI occurrence in TKA surgery and reports 0.3% and 0.3% incidence for PJI and superficial infections respectively in two years. The study sample consists of a non-selected series of consecutive patients and resembles well the population undergoing primary TKA surgery. Our data also indicated that there was a positive relationship between duration of discharge, type of discharge (bloody-purulent), female gender and duration of hospitalization with the occurrence of both superficial infection and PJI. The most common microorganism responsible for PJI and superficial infections was staphylococcus aureus.

In the present study, a discharge drain was inserted in the joint space after surgeries for all patients and we believe that this technique led to a lower incidence of discharges and also long term infections. Previous studies have claimed that PJI and superficial infections could occur in 0.39-1.22% of patients undergoing TKA [11]. However, due to the variations in study methods and definition of infection, comparison between studies is challenging. In a systematic review and meta-analysis that was performed by Zhu and colleagues in China, it was stated that patients with diabetes mellitus, corticosteroid therapy, hypoalbuminemia, wound dehiscence, superficial surgical site infection and prolonged operative time and hospitalization have higher risks of developing PJI and might require repeated surgeries [12].

Another study by MC Castano-Betancourt and others also emphasized that higher duration of discharge and duration of hospitalization are associated with higher risks of superficial infection and PJI [13]. Our results are in line with the findings of these previous studies. An important point of the current study was that we assumed that using drainage after the surgeries could reduce wound discharges and therefore, reduce the risks of PJI and superficial infections. This issue was addressed by Parker and colleagues. They showed that surgical wound drainage after orthopedic surgeries are associated with lower wound discharges and could later, reduce the risks of infections [14]. Using drainage was also explained to reduce

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**Table 2.** Type and duration of discharge, hospital stay duration, culture result and demographic data of patients

Patients		Duration of discharge (days)	Type of discharge	Hospital stay (days)	gender	Age (y)	Organism specified	Synovial fluid WBC	Synovial fluid percentage of PMN s
Patients with superficial wound infections	Patient 1	15	bloody-purulent	4	Female	68	*Staph aureus		
	Patient 2	14	bloody-purulent	4	Female	72	*Staph aureus		
	Patient 3	14	bloody-purulent	5	Female	65	*Staph aureus		
Patients with PJI	Patient 1	15	bloody-purulent	3	Female	61	*Staph aureus	95000	93
	Patient 2	10	bloody-purulent	4	Male	73	**Coag-ve staph	140000	89
	Patient 3	15	bloody-purulent	5	Female	70	*Staph aureus	110000	91

PMN: polymorphonuclear neutrophils, WBC: white blood cells, \*Staphylococcus aureus; \*\*coagulase-negative staphylococcus.

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**Table 3.** Pearson correlation matrix between parameters. *P* value less than 0.05 is considered to be significant

Complication	Age (y)	gender	Duration of discharge (day)	Type of discharge	Occurrence of discharge
PJI	0.83	0.006*	0.001*	0.001*	0.001*
Superficial wound infection	0.94	0.50	0.001**	0.001**	0.001**

\*Significant relations between PJI occurrence with gender, duration of discharge, type of discharge and occurrence of discharge were found. \*\*Positive relations between superficial wound infection occurrence and duration of discharge, type of discharge and occurrence of discharge were found.

the risks of infection in orthopedic surgeries in previous studies. They have stated that reduced discharges and duration of them could prevent the occurrence of PJI and superficial infections [15, 16]. Our data were consistent with these results emphasizing the effectiveness of drainage in reducing the risks of infections.

Based on our results, a longer duration of wound discharge, especially bloody-purulent type could increase the chances of PJI after TKA. Tsaras and others showed that type of discharges after TKA or total hip arthroplasty (THA) is a pivotal prognostic factor for future PJI. They investigated data of 7375 THA or TKA surgeries and showed that the incidence of PJI was 0.5%, 0.8% and 1.4% after 1, 5 and 10 years following arthroplasty with significant correlation with type and duration of wound discharge [17]. It has also been stated that infections with staphylococcus aureus significantly increase the risks of PJI and prosthesis failure [18, 19]. Based on the results of our study, Staphylococcus aureus was found in 5 patients from 6 involved patients. Our results are in line with previous findings.

The higher incidence of PJI and superficial infections in women was also explained by previous studies. They showed that the infection rate was significantly higher in women than men which might be due to higher prevalence of obesity leading to delayed healing in women [20-22]. In this study, patients with infections (either PJI or superficial) had a longer duration of discharge (14.6 days and 13.3 days in PJI and superficial infections respectively, compared to 7.7 days in all of the study population); therefore, surgical site discharge exceeding 8 days suggests infection but does not differentiate between PJI or superficial infection. According to a study by Jaber and others in

2008, patients with discharge more than 7 days have a high probability of PJI and prompt debridement is required and further postponement of debridement leads to undesired results [23].

### Conclusion

In conclusion, bloody purulent discharge reaching seven days postsurgical in TKA patients is highly suggestive of an underlying infection (PJI or superficial infection) but type and duration of discharge could not be used to differentiate between PJI and superficial infection. Other risk factors for PJI or superficial infection include women's gender, longer surgical duration, longer hospitalization and longer discharge duration. We also suggest that more studies on the efficacy of wound drainage after surgeries and their possible roles in reducing the PJI and superficial infection in patients should be performed.

### Disclosure of conflict of interest

None.

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