



Original Article

Impact of time to surgery from injury on postoperative infection and deep vein thrombosis in periprosthetic knee fractures

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ABSTRACT

Purpose: Periprosthetic fracture (PPF) is a serious complication that occurs in 0.3%–2.5% of all total knee arthroplasties used to treat end-stage arthritis. To our knowledge, there are no studies in the literature that evaluate the association between time to surgery after PPF and early postoperative infections or deep vein thrombosis (DVT). This study tests our hypothesis that delayed time to surgery increases rates of postoperative infection and DVT after PPF surgery.

Methods: Our study cohort included patients undergoing PPF surgery in the American College of Surgeons National Surgical Quality Improvement Program database (2006–2015). The patients were dichotomized based on time to surgery: group 1 with time ≤ 2 days and group 2 with time > 2 days. A 2-by-2 contingency table and Fisher's exact test were used to evaluate the association between complications and time to surgery groups, and multivariate logistic regression was used to adjust for demographics and known risk factors.

Results: A total of 263 patients (80% females) with a mean age of 73.9 ± 12.0 years were identified receiving PPF surgery, among which 216 patients were in group 1 and 47 patients in group 2. Complications in group 1 included 3 (1.4%) superficial infections (SI), 1 (0.5%) organ space infection (OSI), 1 (0.5%) wound dehiscence (WD), and 4 (1.9%) deep vein thrombosis (DVT); while complications in group 2 included 1 (2.1%) SI, 1 (2.1%) OSI, 1 (2.1%) DVT, and no WD. No significant difference was detected in postoperative complications between the two groups. However, patients in group 2 were more likely ($p = 0.0013$) to receive blood transfusions (57.5%) than those in group 1 (32.4%).

Conclusion: Our study indicates patients with delayed time to surgery have higher chance to receive blood transfusions, but no significant difference in postoperative complications (SI, OSI, WD, or DVT) between the two groups.

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Introduction

Since the late 1960s, total knee arthroplasty (TKA) has provided increased limb mobility, improved joint mobility, and adequate pain relief in patients with end-stage knee osteoarthritis.^{1–3} In the United States, more than 300,000 TKAs are performed each year; the per capita utilization of the procedure among Medicare beneficiaries is projected to increase nearly 300% by 2025.^{2,4,5} Periprosthetic fracture (PPF) is a serious complication of total knee arthroplasties (TKA) with significant morbidity and mortality.^{6,7}

PPFs most commonly result from low-energy mechanisms, such as falls, motor vehicle collisions, and seizures. Some risk factors include age, female sex, high activity level, corticosteroid therapy, decreased bone mineral density, rheumatoid arthritis, anterior femoral notching, component malpositioning, excessive bony resection, malalignment, osteolysis, and neurologic diseases (e.g. parkinsonism, poliomyelitis, cerebral palsy).^{1,4,5,8–13} Despite this, the prevalence of PPF remains relatively uncommon in patients who undergo TKAs, with only 0.3%–2.5% suffering supracondylar fractures, 1.5%–2.4% patellar fractures, and 0.4%–1.7% tibial fractures.^{1,2,4,8,10,11,14} However, the number of TKA-related PPFs are anticipated to increase as life expectancy, prevalence of obesity, and demand for TKA to include younger and older patients continue to rise.^{10,12,13,15,16}

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Surgical treatment of PPF continues to remain technically challenging. Short distal segment for fixation, significant intraoperative blood loss, and axial malalignment causing abnormal tibial-femoral angle may lead to non-union, mal-union, mechanical failure, limb shortening, and/or varus/valgus angulations.^{1,4,5,9,17,18} In many cases, modified techniques of fracture fixation must be used to accommodate for poor bone quality caused by osteoporosis and osteopenia.² These difficulties can lead to poor outcomes.

The effect of varying time to surgery from injury is a contentious topic. On one hand, surgery delay can increase the chances of complications related to immobilization (e.g. thromboembolism, pressure ulcers, and pulmonary infections); on the other hand, rushed surgery can increase the chances of perioperative complications.¹⁹ Studies relating to the effect of delay of surgery on patient mortality for both primary and PPF hip fractures exist, but are conflicting.^{7,19–21} In addition, another article cites and concurs with previous studies that show no association between delay to surgery and postoperative complications.²² However, no study has evaluated the association between time to surgery after PPF related to TKA and complication rates.

The aim of this study was to utilize the American College of Surgeons (ACS) National Surgical Improvement Program (NSQIP) database to test our hypothesis that delayed time to surgery increases the rates of short-term complications after PPF surgery.

Methods

Our study has been approved by the University of Alabama at Birmingham Institutional Review Board.

Data acquisition and patient selection

The ACS NSQIP database contains surgical outcomes data from more than 500 participating institutions around the United States. Risk- and case-adjusted demographics, operative variables, complications, and comorbidities are collected from the various institutions, and the outcomes of more than 20 categories of morbidity and mortality over 30 days post-operation are reviewed and recorded by trained reviewers. Routine auditing of patient outcomes assure data with merit.²³ More information on the methodology of the program is available in the ACS NSQIP Participant Use Data File guide.²⁴

Patients with PPF who underwent TKA from 2006 to 2015 were selected from the ACS NSQIP database. CPT and ICD 9 codes were used to identify 263 patients: ICD 9 code 996.44, CPT codes 27509 (percutaneous skeletal fixation of femoral fracture, distal end, medial or lateral condyle, or supracondylar or transcondylar, with or without intercondylar extension, or distal femoral epiphyseal separation), 27511 (open treatment of femoral supracondylar or transcondylar fracture without intercondylar extension, includes internal fixation, when performed), 27513 (open treatment of femoral supracondylar or transcondylar fracture with intercondylar extension, includes internal fixation, when performed), 27514 (open treatment of femoral fracture, distal end, medial or lateral condyle, includes internal fixation when performed), 27524 (open treatment of patellar fracture, with internal fixation and/or complete patellectomy and soft tissue repair), 27535 (open treatment of tibial fracture, proximal; unicondylar, includes internal fixation, when performed), 27536 (open treatment of tibial fracture, proximal; bicondylar, with or without internal fixation), 27540 (open treatment of intercondylar spine and/or tuberosity fracture of the knee, includes internal fixation, when performed), 27487 (revision of total knee arthroplasty, with or without allograft; femoral and entire tibial component), and 27486 (revision of total knee arthroplasty, with or without allograft; 1 component).²⁵

Variables and outcomes

In this study, demographics (age, sex, and BMI), preoperative hematocrit level, operation duration, days from hospital admission to operation, and comorbidities (diabetes mellitus, steroid use, and smoking status) were used as patient characteristic variables. These variables were identified as risk factors from the literature.^{10,12,13,21} Thirty-day postoperative superficial incisional infection, deep incisional infection, organ/space infection, wound dehiscence, and DVT and intraoperative number of blood transfusions defined complications from PPF related to TKA surgery.

Statistical analysis

Patients' demographic and clinic characteristics were summarized as mean \pm standard deviation (SD) for continuous variables and as frequency (proportion) for categorical variables. The 263 patients were dichotomized into two groups based on time to surgery: Group 1 with time ≤ 2 days and Group 2 with time > 2 days. This cutoff was used to divide the patients because there is evidence that surgery within 2 days has shown to be more beneficial to patients by reducing complications such as bed sores, pneumonia, and UTIs in hip fracture patients; therefore this logic was applied to this study as well.²⁶ We conducted a multivariate logistic regression analysis to assess the effect of time to surgery (within vs. after 2 days after hospitalization) on post-operative complications while controlling for patient demographics and known risk factors. The group comparison was conducted using a two samples *t*-test for continuous variables and Chi-square test for categorical variables. For those rare events such as complications, Fisher's exact test was used. All statistical analysis was conducted using SAS 9.4 (Cary, NC), and the level of significance was set as $p < 0.05$.

Results

This study identified 263 patients who underwent surgery to treat PPF related to TKA from the ACS NSQIP database. Patient demographics and clinical characteristics, including comorbidities, are summarized in Table 1. Of the 263 patients, 210 (79.8%) were female, 52 (19.8%) were male, and 1 (0.4%) was unidentified. The mean BMI was 31.0 ± 7.9 kg/m² (17.5–58.1); mean age, 73.9 ± 12.0 years old (19–90); mean preoperative hematocrit, 33.9 ± 7.9 g/dL (21.4–49.4); and mean operation time 133.1 ± 52.0 min (30–276). The interval from hospital admission to operation averaged 1.6 ± 2.1 days with a range of 0–18. Two hundred and sixteen patients underwent PPF surgery within the first two days of admission, and 47 patients after two days. Among those patients, 20 (7.6%) were current smokers, 21 (8.0%) were chronic steroid users, and 63 (24.0%) were patients with diabetes mellitus.

Our results suggested that complications, except intraoperative blood transfusions, were rare post PPF surgery related to TKA, with an overall complication rate of 4.6% (12/263). The rate of complications is summarized in Table 2. In both groups, no patients had deep incisional infections or surgical site infection present at the time of surgery. When compared to the patients in the > 2 days group with 47 patients, patients in the ≤ 2 days group with 216 had 3 (1.4%) vs. 1 (2.1%) superficial incisional infections, 1 (0.5%) vs. 1 (2.1%) organ/space infection, 1 (0.5%) vs. no wound dehiscence, 4 (1.9%) vs. 1 (2.1%) deep vein thrombosis, 70 (32.4%) vs. 27 (57.5%) intraoperative blood transfusions, and 2 (1.1%) vs. no sepsis present at the time of surgery. Of all the complications, only the number of blood transfusions given to the patient was significantly lower ($p = 0.0013$) in the ≤ 2 days group (32.4%) compared to the > 2 days group (57.5%).

Table 1
Patient demographics and clinical characteristics, n (%).

Characteristics	Overall (n = 263)	≤2 days (n = 216)	>2 days (n = 47)	p Value
Male	52 (19.8)	41 (19.1)	11 (23.4)	0.4997
Female	210 (79.8)	174 (80.9)	36 (76.6)	0.4997
BMI (kg/m ²)	31.0 ± 7.9	31.0 ± 8.0	30.8 ± 7.3	0.8340
Age (years)	73.9 ± 12.0	73.2 ± 12.3	77.3 ± 9.5	0.0131
Preoperative hematocrit (g/dL)	33.9 ± 7.9	34.6 ± 5.8	30.8 ± 4.3	<0.0001
Operation time (minutes)	133.1 ± 52.0	132.6 ± 51.9	135.8 ± 53.0	0.7050
Time to surgery (days)	1.6 ± 2.1	–	–	–
Current smoker	20 (7.6)	18 (8.3)	2 (4.3)	0.5436
Steroid use	21 (8.0)	16 (7.4)	5 (10.6)	0.4590
Diabetes mellitus	63 (24.0)	46 (21.3)	17 (36.2)	0.0304

Table 2
Intraoperative and postoperative complications, n (%).

Complications	Overall	≤2 days (n = 216)	>2 days (n = 47)	p Value
Superficial incisional infections	4 (1.5)	3 (1.4)	1 (2.1)	0.5473
Deep incisional infections	0	0	0	–
Organ/space infections	2 (0.8)	1 (0.5)	1 (2.1)	0.3260
Wound dehiscence	1 (0.4)	1 (0.5)	0	1.0000
Deep vein thrombosis	5 (1.9)	4 (1.9)	1 (2.1)	1.0000
Surgical site infection present at time of surgery	0	0	0	–
Sepsis present at time of surgery	2 (0.9)	2 (1.1)*	0	1.0000
Blood transfusion given	97 (36.9)	70 (32.4)	27 (57.5)	0.0013

Discussion

As the number of TKAs performed continues to climb and the elderly population expects to ambulate longer, an increase in PPF is expected.² According to Parvizi et al⁴ and a National Hospital Discharge Survey produced by the U.S. Department of Health and Human Services, more than 300,000 TKA were performed in 2008 in the US alone, and the number of PPF related to TKA (Fig. 1) was expected to double from 2002 to the next 10–15 years. Fortunately, even with the spike in TKA and the likely jump in PPF prevalence, the actual PPF rate for primary TKA remains low at around 0.3%–4.2%.¹¹ Similarly, in our study, we were only able to identify 263 patients with PPF who underwent TKA in the ACS NSQIP database that contains more than 3.6 million cases.

The technical difficulty of PPF surgery is noted pervasively in literature. For example, Platzer et al² notes that techniques of fracture fixation often need to be modified due to poor bone

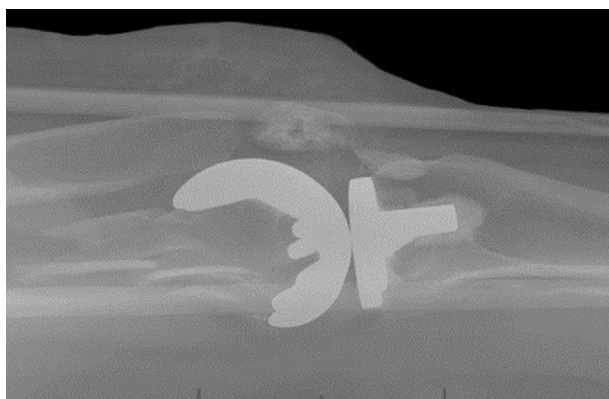


Fig. 1. X-ray image of periprosthetic femur fracture. *Courtesy of Dr. Sameer Naranje and not from database patient.

conditions. For patients to achieve their pre-fracture mobility, flexibility, and comfort after a difficult procedure, thoughtful research and care are required to decrease the rates of complications that may impede patient wellness.

Much research, many with differing results, has been carried out to look for complication and mortality rates in PPF related to total hip replacements. Despite the generally-held opinion that hip fractures should be fixed as soon as possible in elderly patients,²⁷ Zuckerman et al²¹ cites studies by Davis et al²⁸ and Kenzora et al²⁹ that suggest increased mortality rate in patients who had undergone surgery within one or two days, respectively, while concluding themselves that delay of more than 2 days increased mortality in patients with hip fractures. Orosz et al.,¹⁹ on the other hand, states that there is no association between mortality and delay in surgery. Amidst this contentious topic in orthopedics, there exists no research on the effect of time to surgery on postoperative infection and DVT rates of PPF related to TKA.

In this study, we retrospectively analyzed the postoperative infection and DVT rates of patients in the ACS NSQIP database who underwent PPF surgery related to TKA. Similar to the secondary finding of Zuckerman et al²¹ that showed no correlation between postoperative complications and operative delay in patients with hip fractures, we found no statistically significant difference between the ≤2 days group and the >2 days group in any of these complications. This finding may imply that with regard to rates of postoperative infections and DVT, there is no negative consequence of delaying operations in order to better stabilize patients.¹⁹ However, our study did find that a significantly higher proportion of patients in the >2 days group received blood transfusions intraoperatively compared to those in the ≤2 days group (57.5% vs 32.4%; $p = 0.0013$). Such results may indicate more difficult surgical cases with higher volume of patients with acute medical conditions in the >2 days cohort.²¹ We believe patients who were operated on after more than 2 days had significant comorbidities, including preoperative anemia. Hence they were not in optimal condition to undergo surgery earlier and needed more transfusions postoperatively.

Our study also observed some significant differences in the demographics and comorbidities between the two groups. Patients in the >2 days group were older (77.3 ± 9.5 vs 73.2 ± 12.3), had a lower preoperative hematocrit level (30.8 ± 4.3 vs 34.6 ± 5.8), and were more likely to be diabetic (36.2% vs 21.3%). These findings seem to show a patient group with higher risk that may require a delay in surgery when first admitted.

There are inherent limitations to the ACS NSQIP database. Due to the anonymity of geographic identifiers and facility names of the participants of this database, selection bias may exist in which hospitals are included in the dataset, and it is impossible to validate how well the entire country is represented by the cases in the patient cohorts. Moreover, as a database that collects general information on demographics, comorbidities, and outcomes, it is not possible to seek out additional information on patients identified for the study. Because only 30-day complications are recorded, the primary limitation of the study is the lack of long-term data, such as functional status after recovery and mortality rates between the two groups. Furthermore, due to the nature of database study, we were unable to distinguish the different causes and severity of the injuries for the PPF surgeries and, as a result, unable to analyze the impact of different classifications of fractures on the short-term postoperative complication rates. Despite its limitations, ACS NSQIP provided a large cohort of patients with PPF related to TKA that was used to further our knowledge on complication rates, patient counseling, surgeon expectations, and overall outcome.³⁰ Our use of the 48-h demarcation to create the two studied groups introduces another limitation. Group 2 (>2 days) encompasses a wide range of times to surgery, ranging from 2 to 18 days, but this threshold was extrapolated from previous studies on hip fractures which found that patients had fewer postoperative complications when undergoing early surgical repair within 48 h.³¹

In conclusion, our study indicates patients with delayed time-to-surgery have higher chance to receive blood transfusions, but no significant difference in postoperative complications (SI, OSI, WD, or DVT) between the two groups.

Disclosure

The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cjtee.2018.03.005>.

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