

Thirty-day Postoperative Complications following Primary Total Knee Arthroplasty: A Retrospective Study of Incidence and Risk Factors at a Single Center in China

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Abstract

Background: Total knee arthroplasty (TKA) may be associated with serious complications that adversely affect outcomes and increase the likelihood of disability. However, few studies with sufficient sample size have reported postoperative complications following TKA among Chinese patients. This study aimed to evaluate complications of TKA within 30 postoperative days and to identify the related risk factors.

Methods: A retrospective complication-based analysis of TKA using the arthroplasty registry between 2008 and 2013 was performed by summarizing complications of TKA within 30 postoperative days. Multivariate logistic regression was used to identify the predicting factors for complications 30 days after operation.

Results: A total of 1542 patients underwent 2254 primary TKA between January 2008 and December 2013. A total of 137 complications occurred within 30 days after operation with an incidence rate of 6.1%. The incidence rate of major systemic complications within postoperative 30 days was 2.3%, with cardiovascular and respiratory complications as the most common complications. The incidence rates of deep venous thrombosis (DVT) and local complications were 2.4% and 1.0%, respectively. The 30-day postoperative mortality rate was 0.1% (3/2254). Multivariate logistic regression analyses identified body mass index (BMI) of ≥ 30.0 kg/m² (odds ratio [OR]: 1.47) and age ≥ 80 years (OR: 1.87) as significant risk factors for postoperative systemic complications. A BMI of ≥ 30.0 kg/m² was a significant risk factor for DVT (OR: 2.86) and other complications (OR: 2.11). The comorbidity of diabetes was a risk factor for postoperative mortality (OR: 19.20).

Conclusions: This study highlighted complications with cardiac and respiratory origins as the most common complications within 30 postoperative days following primary TKA. The BMI of ≥ 30.0 kg/m² and age ≥ 80 years were significant risk factors for 30-day postoperative complications.

Key words: Postoperative Complication; Risk Factor; Total Knee Arthroplasty

INTRODUCTION

Total knee arthroplasty (TKA) is effective to restore function and improve quality of life of patients with knee arthropathy that has not been effectively managed nonoperatively.^[1,2] However, TKA may be associated with serious complications that adversely affect outcomes and increase the likelihood of disability. Many studies have provided comprehensive evaluations of postoperative mortality and morbidity after TKA based on regional studies^[3] or national registries.^[4] However, most of the studies investigated Western Caucasian patients, and few studies with sufficient sample size have reported the postoperative complications following TKA among Chinese patients. The aim of this study was to perform a complication-based analysis to evaluate the complications of TKA within 30 postoperative days and

to identify the predicting factors for complications among Chinese patients.

METHODS

Ethical approval

The study was conducted in accordance with the *Declaration of Helsinki* and was approved by the Institutional Review

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Board of Peking Union Medical College Hospital. All patients provided their oral informed consents to be included in this retrospective analysis.

Study design

This was a population-based retrospective study. Data were obtained from the knee arthroplasty registry in Peking Union Medical College Hospital. Patients who underwent cemented primary TKA between January 2008 and December 2013 and follow-up clinical visits within 30 postoperative days were retrospectively analyzed. The indications for operations included degenerative osteoarthritis (OA), secondary OA, rheumatoid arthritis (RA), knee arthropathy related to ankylosing spondylitis, and others. Operations were performed by three chief arthroplastic surgeons (no significant differences for the operation time [$P = 0.399$] and total complication rate [$P = 0.056$] among the three surgeons using analysis of variance [ANOVA]). The exclusion criteria were as follows: (1) patients who underwent TKA for hemophilic arthropathy and malignant disease; (2) patients who underwent revision surgery; and (3) patients who underwent hybrid TKA with all-polyethylene tibial components. The case records were reviewed, and demographic data of patients and postoperative complications were recorded.

Tourniquets were used in all cases. A midline skin incision was made with a medial parapatellar capsular incision. Bone cuts were made using prosthesis-specific instruments with measured resection and carefully planned soft-tissue technique. Low-molecular-weight heparin (LMWH) and a foot pump were regularly used as thromboembolic prophylaxis for two weeks postoperatively. Cefuroxime or clindamycin was used as antibiotic prophylaxis within 24 h postoperatively. A drain was placed and was usually removed within the first two postoperative days. Blood transfusion was prescribed when the hemoglobin level was <75 g/L or signs of unstable blood circulation were seen.

The following outcomes were studied: major systemic postoperative complications, deep venous thrombosis (DVT), and local complications within 30 postoperative days. Major systemic complications, such as cardiac, pulmonary, renal, and cerebrovascular complications, necessitated complex medical intervention. Local complications consisted of superficial wound infection and/or delayed wound healing, deep wound infection, peripheral nerve injury, and others. As a severe postoperative complication after TKA, pulmonary embolism (PE) was analyzed separately from other pulmonary complications.

Statistical analysis

This study was intended to define possible benchmarks and not to compare outcome parameters among individual implant designs. Demographic data were presented as mean \pm standard deviation (SD). ANOVA and Chi-square analysis were used to compare the results among different surgeons. Uni- and multi-variate logistic regression analyses were used to determine the effect of individual risk factors on the development of postoperative complications.

Backward step-wise regression was used to prune the model. Predictors for analysis included age (categorized as <60 years, 60–79 years, or ≥ 80 years); gender; body mass index (BMI) (categorized as <25.0 kg/m², 25.0–29.9 kg/m², or ≥ 30.0 kg/m²); American Society of Anesthesiologists classification (1 or 2 vs. 3 or 4); presence or absence of diabetes; etiology for surgery (OA, RA, or others); operation strategy (simultaneous bilateral TKA, staged bilateral TKA, or unilateral TKA); tourniquet duration (categorized as ≤ 89 min, 90–119 min, or ≥ 120 min); anesthesia strategy; and drainage placement. All statistical analyses were performed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA). A $P < 0.05$ was considered statistically significant.

RESULTS

Between January 2008 and December 2013, a total of 1542 patients underwent 2254 primary TKAs at our center. Mean age was 65.0 ± 10.5 years (ranging from 23 to 87 years). In total, 20.1% of patients (310 patients) were male and 79.9% of patients (1232 patients) were female. In total, 588 patients (38.1%) underwent one-stage simultaneous bilateral TKA and 124 patients (8.0%) underwent two-stage bilateral TKA. Among these 124 patients with two-stage bilateral TKA, 65 patients received second bilateral TKA after 3 months (mean time interval between two procedures: 3.5 ± 2.4 years, ranging from 3 months to 8 years), and 59 patients received sequential bilateral TKA during the same hospitalization time (mean time interval between two procedures: 16.1 ± 4.9 days, ranging from 7 days to 28 days). The 918 patients underwent TKA procedures under general anesthesia and 624 patients under nongeneral anesthesia, including epidural anesthesia and nerve block. In total, 339 patients (22.0%) had obesity with BMI ≥ 30.0 kg/m² before operation, in which 12 patients (0.8%) were morbidly obese with BMI ≥ 40.0 kg/m². All the patients were successfully followed up for 30 days after operation: 1254 patients (81.3%) were followed up at outpatient clinic and 288 patients (18.7%) who did not return because of transportation problems were followed up with mailed questionnaires and telephone interviews. The demographic and preoperative characteristics of all patients are summarized in Table 1.

The 30-day postoperative complications were summarized in Table 2. A total of 137 complications occurred within 30 days after operation with an incidence rate of 6.1%. Although regular thrombosis prophylaxis was administered to all patients after operations, 53 symptomatic DVTs (confirmed by ultrasound) and 7 PEs were found, with incidence rates of 2.4% and 0.3%, respectively. Among 51 major systemic complications, cardiovascular events were the most common complications and accounted for 27.5% (14/51), followed by respiratory complications as 19.6% (10/51). There were 23 local complications, including 15 delayed wound healing and/or superficial wound infections, five peripheral nerve injuries, and three deep wound infections. In this study, the mortality rate was 0.1% (3/2254), and the underlying

Table 1: Demographic and preoperative characteristics of all primary total knee arthroplasty patients in this study (n = 1542)

Characteristics	Values
Age (years), mean ± SD	65.0 ± 10.5
Age group, n (%)	
<60 years	358 (23.2)
60–69 years	645 (41.8)
70–79 years	488 (31.7)
≥80 years	51 (3.3)
Gender, n (%)	
Male	310 (20.1)
Female	1232 (79.9)
BMI (kg/m ²), mean ± SD	27.1 ± 4.2
Male	27.2 ± 4.3
Female	27.1 ± 4.3
ASA, n (%)	
1 or 2	1217 (78.9)
3 or 4	325 (21.1)
Anesthesia	
GA	918 (59.5)
Non-GA	624 (40.5)
Indication for operation, n (%)	
OA	1369 (88.8)
RA	143 (9.3)
AS	15 (1.0)
Other diagnosis*	14 (0.9)
Comorbidity of DM, n (%)	
Yes	187 (12.1)
No	1355 (87.9)
Operation information, n (%)	
Unilateral TKA	830 (53.8)
Two-stage bilateral TKA	124 (8.0)
One-stage bilateral TKA	588 (38.1)
Drainage, n (%)	
Yes	1215 (78.8)
No	327 (21.2)
Length of hospitalization (days), mean ± SD	18.1 ± 7.3
Length of postoperative stay (days), mean ± SD	12.6 ± 6.7

*Other indications for primary TKA include posttraumatic OA, pigmented villonodular synovitis, genu varum, genu valgum, and failed previous osteotomy. BMI: Body mass index; ASA: American Society of Anesthesiologists; OA: Osteoarthritis; RA: Rheumatoid arthritis; AS: Ankylosing spondylitis; TKA: Total knee arthroplasty; DM: Diabetes mellitus; GA: General anesthesia; SD: Standard deviation.

reasons for these deaths were respiratory failure, cerebral infarction, and cerebral hemorrhage due to heparin-induced thrombocytopenia.

Multivariate logistic regression analysis was used to identify risk factors for systemic complications, postoperative DVT and/or PE, local complications, and other complications within 30 postoperative days [Table 3]. The BMI of ≥30.0 kg/m² was considered as a significant predictor for systemic complications (odds ratio [OR]: 1.47, 95% confidence interval [CI]: 1.09–1.98; *P* = 0.045), postoperative DVT and/or PE (OR: 2.86, 95% CI: 1.17–6.94; *P* = 0.020), and other complications (OR: 2.11, 95%

Table 2: The 30-day postoperative complications of all primary total knee arthroplasty in this study (N = 2254)

Characteristics	Number of complications	Incidence rate (%)
Deep venous thrombosis	53	2.4
Pulmonary embolism	7	0.3
Major systemic complications	51	2.3
Cardiovascular events	14	0.6
Respiratory events	10	0.4
Urinary tract infection	7	0.3
Cerebrovascular events	3	0.1
Acute renal failure	4	0.2
Others*	4	0.2
Fever without infection	4	0.2
Heparin-induced thrombocytopenia	2	0.1
Mortality	3	0.1
Local complications	23	1.0
Deep wound infection	3	0.1
Superficial wound infection and/or delayed wound healing	15	0.7
Peripheral nerve injury	5	0.2

*Others: Vascular injury, gastrointestinal complication, blood transfusion-related complication, and so on.

CI: 1.10–4.03; *P* = 0.024) within 30 postoperative days. The age ≥80 years was considered as a significant predictor for systemic complications (OR: 1.87, 95% CI: 1.36–2.57; *P* = 0.036). The diagnosis of RA was a significant predictor for postoperative local complications (OR: 2.84, 95% CI: 1.04–7.80; *P* = 0.042). The diagnosis of diabetes was the only significant predictor for 30-day postoperative death (OR: 19.20, 95% CI: 2.30–189.00; *P* = 0.009). Although bilateral TKA was not significantly correlated with 30-day postoperative complications (*P* = 0.140), a trend of higher complication rate for bilateral TKA could be found. In this study, when sequential procedures were performed during the same hospitalization time, the total complication rate within 30 postoperative days was significantly higher than that of the unilateral procedure performed (OR: 3.71, 95% CI: 1.51–9.07; *P* = 0.004). The differences were not significant for one-stage simultaneous bilateral TKA (*P* = 0.122) and staged bilateral TKA after 3 months (*P* = 0.649), compared with unilateral TKA.

DISCUSSION

TKA is a highly effective procedure that provides reliable relief from pain and improves physical function in patients with advanced knee arthropathy. A long-term follow-up study has been reported for Western Caucasians in literature with more than 90% of survival rate 10 years after operation.^[3] For Chinese TKA patients, survival rate of 92.7% during 10-year follow-up with improved clinical outcomes and pain relief was also reported.^[4] Nevertheless, TKA was associated with substantial complications.^[5]

In this study, the incidence rate of the 30-day postoperative complications was reported as 6.1%, which was consistent

Table 3: Multivariate logistic regression analysis for risk factors of postoperative 30-day complications after primary TKA

Risk factors	OR (95% CI)	P
Systemic complications		
BMI ≥ 30.0 kg/m ²	1.47 (1.09–1.98)	0.045
Age ≥ 80 years	1.87 (1.36–2.57)	0.036
ASA classification ≥ 3	1.83 (0.38–7.60)	0.447
Simultaneous bilateral TKA	1.73 (0.62–4.80)	0.296
Diabetes mellitus	1.27 (0.16–9.90)	0.276
General anesthesia	1.63 (0.65–4.08)	0.293
Postoperative DVT and/or PE		
BMI ≥ 30.0 kg/m ²	2.86 (1.17–6.94)	0.020
Operation time of ≥ 120 min	2.30 (0.90–5.60)	0.055
Age ≥ 80 years	3.76 (0.66–15.32)	0.173
General anesthesia	1.90 (0.82–4.50)	0.140
Simultaneous bilateral TKA	1.51 (0.72–3.10)	0.274
Postoperative local complications		
Diagnosis of RA	2.84 (1.04–7.80)	0.042
Operation time of ≥ 120 min	4.18 (0.86–20.00)	0.076
Diabetes mellitus	1.08 (0.21–12.10)	0.110
Simultaneous bilateral TKA	3.22 (0.75–18.00)	0.112
Nondrainage placement	2.42 (0.65–9.80)	0.159
Age ≥ 80 years	2.47 (0.65–9.29)	0.181
Any complications		
BMI of ≥ 30.0 kg/m ²	2.11 (1.103–4.03)	0.024
Male patients	2.63 (1.026–6.72)	0.044
Simultaneous bilateral TKA	1.46 (0.89–2.42)	0.14
Age ≥ 80 years	1.81 (0.49–6.73)	0.183
30-day postoperative death		
Diabetes mellitus	19.20 (2.30–189.00)	0.009

CI: Confidence interval; BMI: Body mass index; ASA: American Society of Anesthesiologists; TKA: Total knee arthroplasty; RA: Rheumatoid arthritis; DVT: Deep venous thrombosis; PE: Pulmonary embolism; OR: Odds ratio.

with the results of previous studies as 5.2–8.1%.^[6–10] This study found that the postoperative major systemic complication rate was 2.3%, and the most common complications were cardiovascular events (the incidence rate of 0.6%) and respiratory problems (the incidence rate of 0.4%). According to the study of Belmont *et al.*,^[9] major systemic complications occurred in 1.83% of patients, which was comparable with the results of this study. Vorhies *et al.*^[10] reported cardiopulmonary disorders to be the primary cause for readmission within 30 days following TKA. It was believed that the cardiovascular complications could be mitigated by strict preoperative medical clearance, as well as close postoperative surveillance and preventative measure implementation.^[11]

With adherence to a perioperative protocol for venous thromboembolism (VTE) prevention, this study reported that the incidence rate of symptomatic DVT and PE was 2.4% and 0.3%, respectively. Belmont *et al.*^[9] reported that the rates of DVT and PE were 1.34% and 0.78%, respectively. Plante *et al.*^[12] reported that the rates of DVT and PE were 1.7% and 0.9%, respectively. In this study, only symptomatic

PE patients verified by computed tomography pulmonary angiography were diagnosed as true PE; additionally, the rate of PE complication was relatively lower in this study than that of previously reported studies.^[5,9,12,13] It was reported that the incidence of PE increased in the recent years for TKA procedure because of the adoption of enhanced detection techniques over time; nevertheless, there was no change in mortality.^[14] Hence, it is necessary to determine whether there has been a true increase in the prevalence of clinically significant PE or whether rates were artificially elevated due to an increase in the use of highly sensitive detection techniques.^[14] Both this study and previous studies indicated that VTE could not be easily avoided after TKA.^[11,13,14] Hence, close surveillance and preventative measure implementation were inevitable during the postoperative period. According to Plante *et al.*'s study,^[12] delayed administration of LMWH therapy has deleteriously impacted the VTE rate after TKA. Prompt initiation of LMWH (12 h after surgery) was suggested.

The incidence rate of local complications was 1.0% in this study. The most common local complications were superficial wound infection and delayed wound healing, which was similar to the results of previous studies.^[9,15] The incidence rate of deep wound infection was 0.1% in this study, and was lower than previously reported, in which a 0.33% of acute periprosthetic infection rate was reported in a cohort study of 4185 TKAs.^[15] Since deep wound complications after primary TKA were associated with a greater risk for the development of deep infection within 2 years,^[16] more attention should be paid in avoiding superficial wound infection to develop into deep wound infection.

The 0.1% mortality rate in this study was lower than previously reported (0.18–0.21%).^[9,14,17] Based on the aforementioned investigations, cardiovascular complications was the most common reason for mortality. However, this result could not be identified in this study. It was reported that decreased duration of hospital stay was coupled with markedly increased readmission rates.^[18] Since the length of postoperative hospitalization stay was about 12.6 days in this study, which was longer than that in Western countries,^[9,11] cardiovascular complications can be mitigated by the close surveillance during the postoperative period and implementation of preventative measures. The results in this study were also consistent with the lower rates of cardiorespiratory complications in a previous study.^[14] Furthermore, with strict preoperative medical evaluation and improvements in perioperative management and multidisciplinary corporation, it is possible to reduce catastrophic outcomes.

In this study, multivariate logistic regression analysis determined several risk factors for postoperative 30-day complications. The BMI of ≥ 30 kg/m² was the significant predictor for systemic complications, postoperative DVT and/or PE, and other postoperative complications, when adjusting for covariates. These findings were consistent with

the results of the previous studies that found obesity as a risk factor for knee reconstruction procedures.^[5,9,15,19-21] In a large Danish study of post-TKA complication, it was found that obesity was a risk factor for postoperative ischemic stroke, acute myocardial infarction, and cardiovascular death, with higher mortality than patients with normal BMI.^[19] A meta-analysis has found higher complication rates in obese and morbidly obese patients, compared with nonobese patients (15% and 22% vs. 9%, respectively).^[22] In this study, we also determined that old age (≥ 80 years) was a risk factor for systemic complications. Elder patients might have complicated comorbidity and have more risks for TKA.^[20,21] It was also reported that the elder patients were at higher risk for developing cardiac, respiratory, and neurological complications.^[23]

Although this study did not find significant differences between bilateral procedures and postoperative complications, which were inconsistent with the results of previous studies,^[24,25] a trend of higher complication rates for bilateral TKA could be found in this study. It was interesting to find that sequential bilateral TKA during the same hospitalization time had significantly higher postoperative complications than that of unilateral procedure. Although staging during the same hospitalization time for bilateral TKA had emerged as a practice to minimize perioperative risks, it was reported that staging within 7 days' bilateral TKA was associated with more frequent complications compared with simultaneous bilateral TKA.^[26] Thus, sequential bilateral TKA should be discouraged.^[26]

This study identified that diabetes was the only significant risk factor for 30-day postoperative mortality. The result was consistent with the results of a previous study, which reported a notable association of diabetes with mortality after primary unilateral TKA (*OR*: 2.99).^[9] There were few cases of mortality in this study, which made it difficult to make safety recommendations according to this study.

This study has several limitations. First, this was a single-center study that provides primary orthopedic surgical care to local population and referrals from other institutions. Thus, the data from one institution may not be comparable with the data from multicenters.^[9,18,21,27] Second, about 18.7% of all the patients were followed up with telephone interviews, which meant that some information might be lost during telephonic follow-up. Third, this study only analyzed the 30-day postoperative complications; some complications that developed more than 30 days after TKA could be missed. Finally, as $<5\%$ of the patients had a BMI of 35 kg/m² or above in this study, a BMI of 35 or 40 kg/m² could not be adopted as the cutoff, which was an indicated cutoff value in the literatures.^[9,19] Large-scale, multicenter studies are required to further elucidate the incidence and risk factors after primary TKA.

In conclusion, this study employed sufficient sample size to determine postoperative complications within 30 days after primary TKA among Chinese patients. Complications

with cardiac and respiratory events were the most common complications within 30 postoperative days. Furthermore, this study discovered that a BMI of ≥ 30.0 kg/m², age ≥ 80 years, and bilateral procedures, especially sequential bilateral TKA during the same hospitalization, were significant risk factors for systemic complications. A BMI of ≥ 30.0 kg/m² was also a risk factor for postoperative DVT. Diagnosis of RA was a risk factor for local complications. Hence, in light of these findings, surgeons and patients can weigh the benefits and risks of TKA before surgery and make a more informed discussion.

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Conflicts of interest

There are no conflicts of interest.

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