



Simultaneous Bilateral Versus Unilateral Total Knee Arthroplasty: A Comparison of 30-Day Readmission Rates and Major Complications



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ABSTRACT

We queried the National Surgical Quality Improvement Program to compare the rate of 30-day readmissions and major complications between simultaneous bilateral and unilateral total knee arthroplasty (TKA). We identified 1771 patients who underwent simultaneous (same-day) bilateral TKA and matched them to a control group of 6790 patients who underwent unilateral TKA. The simultaneous bilateral TKA patients had longer surgery, were more commonly performed under general anesthesia, had a higher rate of postoperative transfusion, and a greater proportion of patients discharged to rehabilitation facilities. Simultaneous bilateral TKA has a low incidence of major complications and was not associated with more readmissions as compared to unilateral TKA (3.6% versus 3.5% respectively). Nonetheless, the odds of major complications was slightly higher following simultaneous bilateral TKA (OR = 1.58).

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The indications and safety of simultaneous bilateral total knee arthroplasty (TKA) have been vigorously debated over the last three decades and remain a controversial issue among orthopedic surgeons, allied health professionals, and hospital administrators [1–3]. Proponents of simultaneous bilateral TKA cite the patient's preference to undergo a single anesthetic and hospitalization, reduced total recovery time, and equivalent functional outcomes compared to staged bilateral TKA [4–6]. Furthermore, the ever-growing demand for primary knee arthroplasty, expected to reach 1.4 million procedures in the USA by 2020 [7], represents a growing financial burden to the American health-care system. Simultaneous bilateral TKA is estimated to reduce costs by almost half compared to staged procedures [8–10], boding well with future cost-containment measures and emphasis on health-care value [11].

On the other hand, proponents of staged bilateral TKA (typically three or more months apart [3]) are primarily concerned with safety and the suspected increased rate of major complications during simultaneous bilateral TKA [12–16]. Proposed changes to the reimbursement of physicians and hospitals in the United States using bundled payments [17] have also raised further concerns regarding unplanned readmissions following bilateral TKA [11]. There are presently few studies comparing readmission rates between bilateral and unilateral TKA

[18]. Furthermore, there are no prospective randomized trials comparing simultaneous to staged bilateral TKA while the dozens of retrospective analyses are plagued by small sample sizes and inherit selection bias [11]. In the absence of level 1 prospective data, multiple meta-analysis [19–22] and even a specialized consensus group [3] have failed to draw strong recommendations pertaining to the indications, safety, and risk of readmission of simultaneous versus staged bilateral TKA.

The American College of Surgeons National Surgical Quality Improvement Program [23] (NSQIP) prospectively collects demographic, perioperative and postoperative data from hundreds of sites across North America. The NSQIP database allows for a prospective, multicenter, and very detailed comparison of readmission rates and perioperative complications between simultaneous bilateral and unilateral TKA. The primary objective of this study was to query the NSQIP database to compare the rate of 30-day hospital readmissions between simultaneous bilateral TKA and unilateral TKA. As a secondary outcome, we sought to compare 30-day major complication rates between procedures. We hypothesized that both the rate of readmissions and major complications would be higher for simultaneous bilateral TKA compared to unilateral TKA.

Methods

Study Population and Data

The NSQIP database is a nationally validated, risk-adjusted, outcome-based program collecting data on patient demographics, comorbidities, perioperative variables, and 30-day postoperative complications following surgical procedures. It is prospectively populated by

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surgical clinical reviewers at different participating institution [23] where variables are precisely defined [24], internally audited, and collected for 30-days even if the patient is discharged from the hospital. The disagreement rate has been reported to be less than 1.8% [23]. Inclusions are continuous and patients cannot be removed or excluded from the database. Participation in NSQIP is voluntary and is growing each year. There are currently over 500 participating sites with the majority situated in the United States (a comprehensive list of participating sites is provided on the NSQIP website [25]).

We queried the NSQIP database from 2011 to 2013 inclusively to identify all cases of elective, primary unilateral TKA and bilateral simultaneous TKA using the Current Procedural Terminology (CPT) code 27447. In this study, simultaneous bilateral procedures denote bilateral TKAs performed under a single anesthetic and therefore include TKAs performed either sequentially or simultaneously by two surgical teams. All the patients with a primary diagnosis code of infection, fracture, or malignancy were excluded. Furthermore, patients with incomplete demographic information, emergency cases, errant concomitant CPT codes, and cases with a wound classification other than “clean” were excluded as this likely indicated a miscoded variable. A total of 1771 patients with primary simultaneous bilateral TKA were identified. These patients were then matched to a control group undergoing unilateral TKA during the same timeframe based on age, gender and American Society of Anesthesiologists (ASA) scores using a 4:1 matching ratio. We chose approximate string matching, which determines approximate matches according to patterns in variables when an exact match is possible. A nearest neighbor matching method was used to locate the matches in the 2 groups based on a greedy matching algorithm. This sorts the patients in the bilateral group by their estimated propensity score and matches each patient sequentially to 4 “nearest neighbor” patients in the unilateral group. This resulted in a matched control group of 6790 patients undergoing unilateral TKA.

Patient baseline characteristics were categorized into demographics, comorbidities, and operative variables (Table 1). Variables with a medical record completion rate below 80% were excluded from the statistical analysis. Comorbidities comprised: body mass index (BMI), diabetes mellitus (all types), smoking, regular steroid use (for a chronic condition), chronic obstructive pulmonary disease (COPD), congestive heart disease (CHF) with dyspnea, hypertension, and American Society of Anesthesiologists (ASA) classification. Laboratory values included hematocrit (%), platelet count ($\times 10^9/L$), blood urea nitrogen (BUN in mg/dL), and creatinine (mg/dL). Finally, operative variables included: type of anesthesia (regional or general), duration of the surgical procedure (minutes), blood transfusion within 72 hours after surgery, and disposition from the hospital. Patients were classified as discharged home if they returned to their primary residence before surgery whereas all other patients were discharged to a rehabilitation center, skilled or unskilled care facility, other facility not considered home, or separate acute care facility.

The 30-day rate of readmission consisted of admission into any hospital for any reason following surgery [24] (including hospitals other than where the index surgery was performed as well as hospitals that are not participating in NSQIP). Thirty-day major complications comprised deep wound infections, pneumonia, pulmonary embolus, acute renal failure requiring dialysis, cerebrovascular accident, cardiac arrest, myocardial infarction, return to the operating room and death. Although it is possible for a patient to have suffered more than one major complication, the statistical analysis was performed using the number of patients who had at least one major complication rather than the absolute number of major complications. For example, if a patient had a pulmonary embolus and later died, this patient was only considered once in the calculation of major complications and logistic regression model.

Statistical Analysis

The baseline characteristics comparing patients undergoing simultaneous bilateral TKA and unilateral TKA were calculated using the

Table 1
Baseline Characteristics of 8561 Patients Undergoing Unilateral and Bilateral TKA.

Baseline Characteristic	Unilateral TKA (N = 6790)	Bilateral TKA (N = 1771)	P-Value
Demographic characteristics			
Age (years)	63.5 (± 8.3)	64 (± 8.6)	0.025
Sex (% female)	3824 (56.3%)	1026 (57.9%)	0.23
Race			
White (%)	5109 (84.1%)	1455 (85.8%)	0.15
Black (%)	483 (8.0%)	112 (6.6%)	
Other (%)	483 (8.0%)	128 (7.6%)	
Medical comorbidities			
Body mass index (kg/m ²)	33.4 (± 7.1)	32.8 (± 6.7)	0.003
Smoker (%)	694 (10.2%)	146 (8.2%)	0.012
Hypertension (%)	4193 (61.8%)	1067 (60.3%)	0.25
Diabetes (%)	1139 (16.8%)	235 (13.3%)	<0.001
COPD (%)	201 (3.0%)	35 (2.0%)	0.023
CHF and dyspnea (%) ^a	393 (5.8%)	87 (4.9%)	0.16
History of steroid use (%) ^b	213 (3.1%)	56 (3.2%)	0.94
Preoperative laboratories			
Creatinine (mg/dL)	0.91 (± 0.43)	0.88 (± 0.35)	0.008
Blood urea nitrogen (mg/dL)	17.5 (± 7.1)	17.9 (± 7.9)	0.069
Hematocrit (%)	41.0 (± 4)	40.9 (± 4.2)	0.24
Platelets (per μL)	244 (± 66.9)	246 (± 64.2)	0.25
Operative variables			
ASA Classification			0.93
1	232 (3.4%)	60 (3.4%)	
2	3927 (57.8%)	1016 (57.4%)	
3	2564 (37.8%)	675 (38.1%)	
4	67 (1%)	20 (1.1%)	
Anesthesia			<0.0001
Regional (%)	2673 (39.5%)	460 (26%)	
General (%)	4101 (60.5%)	1308 (74%)	
Length of surgery (minutes)	95 (± 36)	153 (± 55)	<0.0001
Transfusion within 72 h (%)	737 (10.9%)	667 (37.7%)	<0.0001
Discharge			<0.0001
Home (%)	5127 (75.6%)	590 (33.3%)	
Rehab (%)	1658 (24.4%)	1180 (66.7%)	
Length of stay (days)	3.1 (1.3)	3.7 (1.9)	<0.0001

COPD, chronic obstructive pulmonary disease; CHF, congestive heart failure; ASA, American Society of Anesthetists.

^a CHF and dyspnea include history of congestive heart failure as well as dyspnea at rest or on exertion.

^b Patient required regular steroid use within 30 days of surgery for a chronic medical condition.

Fisher's exact test for binary variables and a 2-sample t-test for continuous variables. Multiple categorical variables were compared using a chi-square test. Continuous variables were reported as mean \pm standard deviation (SD) while categorical variables were expressed as absolute values and percentages (Table 1). Unadjusted 30-day readmission and major complication rates were calculated in a similar fashion (Table 2).

A multivariable logistic regression model was used to examine the independent effect of a patient's type of surgery (unilateral versus bilateral TKA) on the 30-day readmission rate and major complication rate while controlling for all other variables. Independent variables included those in Table 1 since these were thought to be potential confounders in the relationship of type of surgery and 30-day rate of readmission and major complication. The baseline model was created using a priori knowledge and included initial variables believed to be important confounders and worth controlling. Interaction and nonlinear terms were added to future models while variables believed to be unlikely true confounders were excluded from the final model. The stability of future models was assessed by comparing the chi-square likelihood ratio, $-2 \log L$ and AIC to previous models. A final model was chosen based upon its ability to best predict a readmission or

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