



Is Bilateral Total Knee Arthroplasty Staged at a One-Week Interval Safe? A Matched Case Control Study



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ABSTRACT

Controversy surrounds the safety of bilateral total knee arthroplasty (TKA) and whether staging the procedures one week apart represents a safer option. A consecutive series of 234 patients underwent either a simultaneous (103 patients) or staged bilateral TKA (131 patients) from 2007 to 2012 and were compared to a matched control group of unilateral TKA (131 patients). Staged patients had no difference in one-year complication rate when compared to simultaneous bilateral TKA and the matched unilateral TKA control group (15% vs. 19% vs. 15%, $P = 0.512$). There was also no difference in perioperative complications (10% vs. 14% vs. 7%, $P = 0.231$) or 90-day readmissions (8% vs. 4% vs. 4%, $P = 0.295$). In selected patients with bilateral knee OA, TKA staged at a one-week interval is a safe alternative.

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The decision to perform simultaneous bilateral total knee arthroplasty (TKA) or a staged procedure in patients with severe degenerative arthritis of both knees continues to be controversial. Simultaneous bilateral TKA offers several advantages to the patient including an operation done under one anesthetic and a single rehabilitation period. The burden on the health care system is also less, as simultaneous TKA has been shown to result in decreased cost and shorter hospital stay [1–6]. The literature, however, also reports higher perioperative complication rates and increased blood transfusions when compared to unilateral TKA [7–10]. While some studies suggest a higher mortality rate for patients undergoing simultaneous bilateral TKA [8,11,12], these patients have been shown to have greater long term survival in other studies [13].

Some orthopedic surgeons recommend against performing bilateral simultaneous TKA and suggest performing the two procedures staged at least a few months apart during two separate admissions [7–9]. While this approach affords the patient time to recover from the physiologic insult of a simultaneous procedure, there is a marked delay in achieving maximal clinical outcomes until the second knee has been replaced [14]. The optimum time frame between staged procedures continues to be of much debate [15]. Few studies have addressed the safety of staged bilateral TKA one week apart [10,16,17], but this time frame may represent a compromise between faster recovery and patient safety.

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The primary purpose of this study is to determine if patients with bilateral knee osteoarthritis selected to have a staged procedure at a one-week interval have different rates of complications compared to patients having a unilateral TKA or a simultaneous bilateral surgery.

Materials and Methods

We retrospectively reviewed the department's arthroplasty database for all patients who underwent simultaneous and staged bilateral total knee arthroplasty performed by the two senior authors (CLN and CLI) from 2007–2012. Patients were cross-checked for accuracy against the surgeons' personal records. All patients over age 18 who underwent a simultaneous or staged procedure were included in the study. Patients qualified for a bilateral procedure if they had degenerative arthritis of both knees, have failed conservative management, and desired surgical intervention on both knees. The decision to proceed with a staged or simultaneous procedure was made between the patient and surgeon based upon the patient's medical comorbidities, ability to participate in therapy postoperatively, and preference of the patient. All staged bilateral total knee arthroplasty procedures were conducted according to our hospital's protocol. Patients were admitted following their first procedure. When deemed medically stable, they were transferred to our institution's skilled nursing facility (SNF) to await their second procedure seven days after the first. Unless contraindicated, all patients received low molecular weight heparin (LMWH) for DVT prophylaxis postoperatively. For patients undergoing a staged procedure, the LMWH was stopped the night prior to surgery and no DVT screening was performed prior to the procedure. No outside funding was received for this study and it was approved and conducted

according to the guidelines set forth by our Institutional Review Board (IRB).

In order to standardize complication rates of staged bilateral TKA patients, we created a matched control group of unilateral TKA patients. Of the 1044 unilateral TKA procedures performed by the same surgeons over the same time frame, we identified 131 patients matched to the staged group by age and American Society of Anesthesiologists (ASA) score. When multiple patients had the same age and ASA score, a random number generator was used to select the patient for inclusion into the study. The matching process was blinded to the outcome variables.

Patient demographic data, ASA score, preoperative medical comorbidities, and blood transfusions were documented from the medical record. A Charlson Comorbidity Index was calculated for each patient [18]. Length of stay was calculated as the total number of inpatient hospital days and did not include time spent at the SNF. Inpatient discharge summaries, progress notes, laboratory values, and consultation reports were then reviewed for each patient to identify any perioperative complications during the index hospital admission, 90-day readmission rates, and reoperation at any time. We classified and stratified each post-surgical complication based on published definitions from the TKA Complications Workgroup of the Knee Society [19,20]. Each complication was graded I to V based on severity as determined by the Workgroup using a modification of the criteria set by Sink et al [20,21]. Grade I complications such as urinary tract infection, constipation, elevated creatinine postoperatively which resolved without treatment were excluded. Post-operative anemia requiring blood transfusions was documented separately. When defining the time frame for complications, we limited follow-up for medical complications to 90 days and reoperation to one year, as complications outside this time frame would likely not be related to a bilateral procedure.

Statistical Analysis

We performed an *a priori* power analysis to determine the appropriate sample size before the study. Our primary statistical goal was to determine any significant difference in the rate of complications between staged bilateral TKA and the matched control unilateral TKA group. To detect a medium clinically important effect size of 0.30 using a chi-square test with a power of 0.80 and type I error rate of 0.05 [22,23], we would need a minimum sample size of 88 patients in each cohort. Binary outcome variables between our case and control groups were analyzed using Pearson’s chi-square test. Continuous or integer variables such as age, BMI, and Charlson Comorbidity Index were analyzed using a one-way analysis of variance (ANOVA). When only comparing these variables between staged TKA group and the matched unilateral group, a two-tailed Student’s t-test was used. Statistical significance was set at $P < 0.05$.

Results

A consecutive series of 234 bilateral total knee replacement patients and 131 matched unilateral patients (599 TKAs) from two surgeons at a single academic institution between 2007 and 2012 were retrospectively reviewed. No patients were excluded from the bilateral groups in the study. There were 108 males (30%) and 257 females (71%) with a mean age of 63.0 years (range 23–87). Patients had a mean Charlson Comorbidity Index of 0.97 (range 0–6) and mean length of stay of 5.03 days (range 2–34). Demographic data of the patient population are presented in Table 1.

Patients in the simultaneous group were younger (59.4 vs. 64.2 vs. 64.6 years $P < 0.001$) and had a lower BMI (31.7 vs. 36.0 vs. 34.2, $P < 0.001$) than those in the staged and unilateral groups. Patients who underwent simultaneous bilateral TKA had lower ASA scores (2.34 vs. 2.51 vs. 2.51, $P = 0.027$) and a lower mean Charlson

Table 1
Descriptive Statistics of All Bilateral Total Knee Replacements in the Study.

	Mean (SD)		Number (%)
Age (years)	63.0 (9.9)	Male	108 (30)
Length of stay (days)	5.03 (2.88)	Female	257 (71)
Follow-up (months)	55.6 (17.0)	Staged 1 week apart	131 (36)
Preoperative hemoglobin (g/dL)	13.0 (1.4)	Simultaneous bilateral	103 (28)
Blood transfused (units)	1.24 (1.4)	Unilateral TKA	131 (36)
ASA	2.46 (0.55)	Required transfusion	201 (55)
BMI	34.2 (8.3)	Hypertension	264 (72)
Charlson Comorbidity Index	0.97 (1.2)	Hyperlipidemia	124 (34)
		Diabetes mellitus	80 (22)
		Coronary artery disease	60 (16)
		Chronic obstructive pulmonary disease	24 (7)
		Chronic renal insufficiency	18 (5)
		Human immunodeficiency virus	5 (1)
		Hepatitis B or C	18 (5)
		Mortality	1 (0.3)
		90-Day readmission	19 (5)
		Reoperation at any time	17 (5)
		Perioperative complication	38 (10)
		One-year complication rate	58 (16)

Comorbidity Index (0.53 vs. 1.06 vs. 1.22, $P < 0.001$) than the staged and unilateral groups as well. Comparative data between groups are detailed in Table 2. When compared only to the matched control group, the staged bilateral TKA group had no statistical difference with respect to age ($P = 0.725$), BMI ($P = 0.098$), or Charlson Comorbidity Index ($P = 0.297$).

The most common complication was a pulmonary event in 12 patients, followed by cardiovascular in 11 patients, and neurologic complication in 10 patients. Seven patients, all in the bilateral groups, had a DVT or pulmonary embolism. There was one mortality in the staged group that occurred after the second procedure due to a myocardial infarction. The complete list of complications is detailed in Table 3. Twelve patients required reoperation at greater than one year follow-up, which were not included in our analysis of complications. Nine patients were revised late for aseptic loosening, one had a periprosthetic fracture, one had a deep periprosthetic infection requiring explanation and eventual above knee amputation, and one had a synovectomy.

Patients who underwent both staged and simultaneous procedures had low overall rates of complications (15% and 19%, respectively) with no significant difference when compared to unilateral TKA (15%, $P = 0.512$). There was no difference in major grade IV complications

Table 2
Comparison of Patients Undergoing Simultaneous Bilateral TKA, Unilateral TKA, and Those Staged One Week Apart.

Patient Data	Unilateral (n = 131)	Staged (n = 131)	Simultaneous (n = 103)	P Value
Age (years) (SD)	64.6 (9.5)	64.2 (9.7)	59.4 (9.6)	< 0.001
Length of stay (days) (SD)	3.8 (3.4)	7.2 (1.9)	3.8 (1.6)	< 0.001
Preoperative hemoglobin (g/dL) (SD)	12.9 (1.3)	12.7 (1.4)	13.3 (1.4)	0.008
Blood transfused (units) (SD)	0.64 (1.0)	1.45 (1.4)	1.74 (1.5)	< 0.001
ASA (SD)	2.51 (0.55)	2.51 (0.55)	2.34 (0.55)	0.027
BMI (kg/m ²) (SD)	34.2 (3.4)	36 (9.2)	31.7 (6.6)	< 0.001
Charlson Comorbidity Index (SD)	1.22 (3.4)	1.06 (1.2)	0.53 (0.9)	< 0.001
Male (%)	40 (31)	30 (23)	38 (37)	0.064
Required transfusion (%)	43 (33)	85 (65)	73 (71)	< 0.001
Diabetes mellitus (%)	36 (27)	38 (29)	6 (6)	< 0.001
Coronary artery disease (%)	23 (18)	26 (20)	11 (11)	0.156
COPD (%)	8 (6)	14 (11)	2 (2)	0.027
Chronic renal insufficiency (%)	8 (6)	8 (6)	2 (2)	0.254
HIV (%)	1 (1)	2 (2)	2 (2)	0.729
Hepatitis B or C (%)	3 (2)	6 (5)	9 (9)	0.075

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