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# Perioperative Outcomes Following Unilateral Versus Bilateral Total Knee Arthroplasty

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ABSTRACT

Simultaneous bilateral total knee arthroplasty (SB-TKA) is potentially a cost saving manner of caring for patients with bilateral symptomatic knee arthritis. We performed a retrospective analysis using the 2010–2012 American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) to evaluate the risk of perioperative complication following SB-TKA. Demographic characteristics, comorbidities, and 30-day complication rates were studied using a propensity score-matched analysis comparing patients undergoing unilateral TKA and SB-TKA. A total of 4489 patients met the inclusion criteria, of which 973 were SB-TKA. SB-TKA was associated with increased overall complications ($P = 0.023$), medical complications ($P = 0.002$) and reoperation (OR 2.12, $P = 0.020$). Further, total length of hospital stay (4.0 vs 3.4 days, $P < 0.001$) was significantly longer following bilateral surgery.



Total knee arthroplasty (TKA) has long been shown to be both safe and efficacious for the treatment of degenerative conditions of the knee: relieving pain, restoring function, correcting deformity, and providing measurable improvements in quality of life [1–4]. Additionally, from a population health perspective, TKA has been demonstrated to be a cost effective treatment for symptomatic knee arthritis with estimates between ten and twenty thousand dollars per Quality Adjusted Life Year (QALY) [5,6]. In the United States in relationship to the rise in obesity, an aging population, and expanding surgical indications, there is a near exponential increase in symptomatic knee osteoarthritis and the subsequent demand for TKA [7]. Frequently patients present with bilateral symptomatic disease and deformity, which cause patients and surgeons to give consideration to simultaneous bilateral total knee arthroplasty (SB-TKA). For these patients, uncomplicated SB-TKA has been advocated as economically advantageous and efficient compared to the total cost and time of recovery for two separate unilateral TKA surgeries [8]. General cost of care for SB-TKA has been shown to be reduced by 18% to 26% and total hospital length of stay shortened from 6 to 4 days compared with staged bilateral TKA (StgB TKA). In keeping with a perceived decreased work effort and cost for SB-TKA compared to StgB TKA, several third party payers, including Medicare and Medicaid, decrease reimbursement for the surgeon and hospital by 50% if a second total knee arthroplasty is performed within 90 days of the first total knee [9].

Although economic factors have been shown to favor SB-TKA over staged procedures, concern exists regarding potential increased rates of peri-operative morbidity and mortality [8–13]. While historical reports of SB-TKAs showed outcomes comparable to a unilateral total knee arthroplasty with respect to hospital length of stay and wound complications, [10–12] more recent analyses have shown an increased rate of perioperative complications with SB-TKA. Compared with unilateral TKA, there are reported increased risks of pulmonary embolism, need for blood transfusion, and higher rates of mortality with SB-TKAs [1]. In one study, patients older than 70 years of age with pre-existing pulmonary conditions had a 3-fold higher risk of postoperative complications when undergoing SB-TKA as compared to unilateral TKA [13]. In addition, post-operative complications are now considered indicators of quality, are publicly reported, and will be linked to reimbursement, thus potentially creating a negative fiscal incentive to perform SB-TKA [14]. Lastly, post-operative complications likely impose a significant but infrequently quantified cost burden on the American health care system [15].

Given the controversy regarding indications, outcomes, and potential risks and benefits of SB-TKA we sought to utilize the American College of Surgeons-National Quality Improvement Program (ACS-NSQIP) dataset to perform a population based assessment

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comparing medical and surgical complication risk in patients undergoing unilateral TKA and SB-TKA.

## Methods

We performed a retrospective analysis using the 2010–2012 ACS-NSQIP dataset. Details of the dataset have been described previously [16]. In brief, the program includes 394 participating institutions across the United States and captures over 200 perioperative variables. Postoperative morbidity and mortality outcomes are tracked for 30 days regardless of discharge status. Participating institutions include academic medical centers, community hospitals and surgical centers that participate at their own discretion. Tracked variables include patient demographics and comorbid factors; intraoperative variables; laboratory values; and 30-day complications. These variables are prospectively collected and analyzed by dedicated clinical reviewers at each participating site in a standardized fashion. Each site employs surgical clinical reviewers who are rigorously trained to collect data through chart review and, in certain cases, discussion with the treating surgeon and/or patient, allowing for robust, quality data with demonstrated inter-rater reliability [16,17].

The NSQIP database was queried for patients who underwent either unilateral or simultaneous bilateral primary total knee arthroplasty by Current Procedural Terminology (CPT) codes variables in NSQIP (27447). Patient demographic characteristics, preoperative comorbidities, laboratory data, and 30-day perioperative outcomes were recorded.

All variables were used as defined in the NSQIP User Guide. Outcomes of interest included post-operative 30-day complications, reoperation, hospital length of stay, readmission, and mortality. Overall complications were divided into surgical and medical. Variables with over 50% missing data were excluded. Propensity scores estimated with logistic regression using demographics, comorbidity data, and laboratory values were used to match unilateral to bilateral TKA patients in order to reduce confounding between cohorts. Calculated propensity scores for each patient were obtained using a logistic regression model and matched pairs were created using a 1:4 variable ratio, parallel, balanced nearest neighbor approach. Baseline demographics, comorbidities, and lab values were compared across the groups using generalized linear models adjusting for matched group with a log-link. Outcomes were then compared between these matched cohorts using generalized linear models with logit link for binomial outcomes or log-logit for length of stay. A clustered proportional hazards model was fit for time to discharge. Demographics are presented as percentages for categorical variables, and means and standard deviations for continuous variables. Measures of risk for outcomes are presented as odds ratios or hazard ratios (for time to discharge), and least square means for total hospital days. Estimates are presented with corresponding 95% confidence intervals. All analyses were run in SAS v9.4 (Cary, NC), and the level of significance was set at the nominal $P < 0.05$.

## Results

There were 43,393 total knee arthroplasties in the ACS-NSQIP 2010–2012 dataset, of which 1105 (2.6%) were SB-TKAs. A total of 973 SB TKAs were matched at an average of 1:3.7 with 3516 unilateral TKA cases. (Table 1) After matching, there was no significant difference in demographic, laboratory, or comorbidity variables between unilateral TKA and SB-TKA groups.

There was no significant difference between matched cohorts in rates of surgical complications ($P = 0.267$), including peri-prosthetic infection ($P = 0.982$), or readmission rate ($P = 0.675$) or 30-day mortality ($P = 0.925$). However, SB-TKA was associated with increased overall complications (OR 1.48, $P = 0.023$), medical complications (OR 1.88, $P = 0.002$) and reoperation risk (OR 2.12, $P = 0.020$) compared to unilateral TKA (Table 2). Further, total length of hospital stay (4.0 vs 3.4 days, $P < 0.001$) was significantly longer following SB-TKA.

**Table 1**
Demographics and Baseline Characteristics for the Unilateral and Simultaneous Bilateral Total Knee Arthroplasty Cohorts.

| | Unilateral | Bilateral | *P* |
|---|---|---|---|
| N | 3516 | 973 | |
| age | 64.3 ± 10.1 | 64.0 ± 8.6 | 0.204 |
| ASA class | | | 0.925 |
| 1 | 112 (3.2) | 33 (3.4) | |
| 2 | 1931 (54.9) | 532 (54.7) | |
| 3 | 1412 (40.2) | 390 (40.1) | |
| 4 | 50 (1.4) | 13 (1.3) | |
| Bleeding disorder | 63 (1.8) | 17 (1.8) | 0.925 |
| Race | | | 0.494 |
| White | 3005 (85.5) | 830 (85.3) | |
| Black/AA | 175 (5.0) | 54 (5.6) | |
| Asian | 98 (2.8) | 34 (3.5) | |
| Other/unknown | 238 (6.7) | 55 (5.6) | |
| General Anesthesia | 2354 (67.1) | 659 (67.7) | 0.493 |
| Diabetes | | | 0.895 |
| IDDM | 87 (2.5) | 26 (2.7) | |
| NIDDM | 414 (11.8) | 118 (12.1) | |
| Current smoker | 283 (8.1) | 81 (8.3) | 0.793 |
| Functional status | | | 0.187 |
| Independent | 3436 (97.7) | 944 (97.0) | |
| History COPD | 75 (2.1) | 20 (2.1) | 0.878 |
| Hypertension medication | 2242 (63.8) | 618 (63.5) | 0.880 |
| Steroid use | 105 (3.0) | 26 (2.7) | 0.604 |
| BMI | | | 0.954 |
| Underweight | 14 (0.4) | 3 (0.3) | |
| Healthy weight | 332 (9.4) | 84 (8.6) | |
| Overweight | 1003 (28.5) | 286 (29.4) | |
| Obese class I | 1010 (28.7) | 279 (28.7) | |
| Obese class II | 650 (18.5) | 184 (18.9) | |
| Obese class III | 507 (14.4) | 137 (14.1) | |

ASA, American Society of Anesthesiologists; AA, African American; IDDM, insulin-dependent diabetes mellitus; NIDDM, non-IDDM; COPD, chronic obstructive pulmonary disease; BMI, body mass index.

Table 3 shows the "raw" or absolute percentage of postoperative complications comparing unilateral versus bilateral total knee arthroplasty. Of note, there was a positive association between increasing ASA class and post-operative morbidity risk in both the unilateral TKA and SB-TKA groups.

## Discussion

Total knee arthroplasty has demonstrated reproducible benefits in quality of life for patients with symptomatic knee arthritis. The demand for TKA has been projected to increase dramatically over the coming decades and the manner in which these surgeries are implemented will significantly impact the health care system in the areas of cost and quality [18]. For patients with bilateral knee involvement, the timing of surgical intervention is of paramount importance.

Despite controversy regarding the safety of SB-TKA, it has comprised 4%–6% of all TKAs performed annually in the United States over the last several decades [6]. Advocates of SB-TKA cite multiple proposed benefits: decreased cost, quickened recovery, avoidance of multiple

**Table 2**
Odds Ratios for 30-Day Outcomes Comparing Simultaneous Bilateral to Unilateral Procedures.

| Outcome | Odds Ratio, 95% Confidence Interval, *P* Value |
|---|---|
| Overall Complications (N = 211) | 1.48 (1.09, 2.02) $P = 0.023$ |
| Surgical Complications (N = 56) | 0.69 (0.34, 1.43) $P = 0.267$ |
| Superficial wound infection (N = 34) | 0.62 (0.24, 1.63) $P = 0.268$ |
| Deep/joint space infection (N = 14) | 0.99 (0.27, 3.54) $P = 0.982$ |
| Medical Complications (N = 162) | 1.88 (1.34, 2.65) $P = 0.002$ |
| Reoperation (N = 60) | 2.12 (1.25, 3.58) $P = 0.020$ |
| Length of stay (Hazard ratio) | 1.31 (1.22, 1.41) $P < 0.001$ |
| Readmission (N = 52) | 0.86 (0.41, 1.81) $P = 0.675$ |
| Mortality (N = 5) | 0.90 (0.10, 8.10) $P = 0.925$ |