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Original Research

Unicompartmental Knee Arthroplasty vs Total Knee Arthroplasty: A Risk-adjusted Comparison of 30-day Outcomes Using National Data From 2014 to 2018

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ABSTRACT

Background: When clinically indicated, the choice of performing a total knee arthroplasty (TKA) vs a unicompartmental knee arthroplasty (UKA) is dictated by patient and surgeon preferences. Increased understanding of surgical morbidity may enhance this shared decision-making process. This study compared 30-day risk-adjusted outcomes in TKA vs UKA using a national database.
Methods: We analyzed data from the National Safety and Quality Improvement Program database, for patients who received TKA or UKA between 2014-2018. The main outcomes were blood transfusion, operation time, length of stay, major complication, minor complication, unplanned reoperation, and readmission. Comparisons of odds of the outcomes of interest between TKA and UKA patients were analyzed using multivariate regression models accounting for confounders.
Results: We identified 274,411 eligible patients, of whom 265,519 (96.7%) underwent TKA, while 8892 (3.3%) underwent UKA. Risk-adjusted models that compared perioperative and postoperative outcomes of TKA and UKA showed that the odds of complications such as blood transfusion (adjusted odds ratio [aOR], 19.74; 95% confidence interval [CI]: 8.19-47.60), major (aOR, 1.87; 95% CI: 1.27-2.77) and minor complications (aOR, 1.43; 95% CI: 1.14-1.79), and readmission (aOR, 1.41; 95% CI: 1.16-1.72) were significantly higher among patients who received TKA than among those who received UKA. In addition, operation time (aOR, 7.72; 95% CI: 6.72-8.72) and hospital length of stay (aOR, 1.11; 95% CI: 1.05-1.17) were also higher among the TKA recipients compared to those who received UKA.
Conclusions: UKA is associated with lower rates of adverse perioperative outcomes compared to TKA. Clinical indications and surgical morbidity should be considered in the shared-decision process

Introduction

Total knee arthroplasty (TKA) and unicompartmental knee arthroplasty (UKA) are both commonly used procedures for treating single-compartment osteoarthritis (OA) of the knee. There are multiple opinions about which of the 2 treatment options could provide optimal postoperative results for these patients [1]. The TKA procedure has long been considered the gold standard treatment due to improved reliability, durability, predictability, pain control, and functional outcome [2–5]. In contrast, several studies have shown that UKA is associated with better knee kinematics and improved satisfaction [6–10]. Nevertheless, studies have shown that both types of procedures provide comparable improvements in quality of life [11,12].

While individual studies have differed in their conclusions regarding the 2 procedures, meta-analyses have also been inconsistent in the comparison of both. For example, in a meta-analysis

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conducted by Zhang et al., UKA was associated with better postoperative function and fewer complications, while TKA was associated with lower rates of surgical revisions during the 5-year postoperative period [13]. In another meta-analysis that compared these 2 procedures, UKA showed better outcomes in several domains such as shorter hospital length of stay, lower rates of medical complications, decreased mortality, lower rates of deep tissue infections, and better functional recuperation. In contrast, TKA showed lower rates of revision surgeries [14]. As this topic remains controversial, analyzing recent large-population data sets can add to the body of research in this field and aid in surgical decision-making. Therefore, we compared 30-day risk-adjusted outcomes between UKA and TKA using a national database. We hypothesized that patients who had UKA procedures would have better clinical outcomes than those undergoing TKA procedures.

Material and methods

Study design and population

This study is a retrospective analysis of National Safety and Quality Improvement Program (NSQIP) data. The American College of Surgeons (ACS) created the NSQIP to collect data on perioperative variables, preoperative morbidity, and 30-day postoperative complications for major surgical procedures [15]. The NSQIP database comprises data collected by trained surgical reviewers at each participating institution, using meticulous and elaborately defined parameters to determine each patient's health status from presurgical to postsurgical stages [16]. In order to ensure that essential variables are collected for at least 30 days after discharge, information is collected through telephone interviews when patients are discharged before 30 days. The ACS periodically audits the NSQIP data, ensuring high inter-observer reliability, and hence, end user disagreement rates are less than 1.8%. The NSQIP includes data collected from over 500 sites located internationally as well as within the United States. NSQIP database has been extensively documented in both general surgery and orthopedic literature regarding short-term outcomes after surgery [17–20].

Data collection & variables

All patients aged 18 years or older who underwent either a UKA or TKA between 2014 and 2018 were identified using data from the NSQIP database. Current Procedural Terminology codes 27446 and 27447 (UKA and TKA, respectively) identified the performed surgical procedures. For the purposes of this study, we analyzed demographic variables such as age, sex, race, and ethnicity, as well as comorbidities such as body mass index (BMI), diabetes, smoking status, chronic obstructive pulmonary disease (COPD), hypertension, and bleeding disorders. We also assessed perioperative variables including anesthesia types and the American Society of Anesthesiologists (ASA) physical status classification, total operation time, length of stay, and discharge disposition. Other postoperative variables of interest were requirements for blood transfusion, readmission, and death, as well as the presence and type of complications. We aggregated data for events of urinary tract infections, pneumonia, superficial surgical site infections, deep surgical site infections, wound disruptions, progressive renal insufficiency, and deep vein thrombosis/thrombophlebitis as minor complications. Major complications comprised events such as myocardial infarctions, cardiac arrests, cerebrovascular accidents, acute renal failure, ventilator support lasting more than 48 hours, unplanned intubations, pulmonary embolism, sepsis, septic shock, and death.

Statistical analysis

All data were analyzed using SAS version 9.4 (SAS Institute, Cary, NC). Bivariate differences in means and proportions between TKA and UKA were calculated using the Wilcoxon Rank Sum test and Chi-square test, respectively. We analyzed the odds of longer operation times, blood transfusions, longer length of stay, and 30-day outcomes (minor and major complications, reoperations, and readmissions) between TKA and UKA using multivariate regression models. In our models, we adjusted for age, sex, race/ethnicity, anesthesia type, smoking, BMI, congestive heart failure, COPD, dialysis, ascites, dyspnea, diabetes, cancer, hypertension, kidney disease, low preoperative serum albumin, anemia, bleeding disorder, acute renal failure, steroid use, and ASA classification.

Results

The final population included in our study was 274,411 patients (mean ± standard deviation age, 66.7 ± 9.5 years; 61% female; 67.1% white/Caucasian). Table 1 shows the demographic and clinical characteristics of the included patient population. Patients who had a TKA were slightly older than those who had a UKA (66.8 vs 64.4 years, $P < .001$). We also observed significant differences across gender, race and ethnicity, mean BMI, and other clinical characteristics. In particular, proportionally more patients who had UKA were hypertensive (43.8% vs 35.3%, $P < .001$) and active smokers (9.4% vs 8.3%, $P < .001$). Conversely, more patients who had a TKA had diabetes (18.3% vs 15.4%, $P < .001$) and COPD (3.5% vs 2.9%, $P < .001$).

Table 2 details perioperative and postoperative characteristics and outcomes of the patient population under study. On average, patients who had a TKA had a longer in-hospital length of stay (2.5 days vs 1.4 days, $P < .001$) and more major (1.1% vs 0.6%) and minor complications (2.6% vs 1.7%). Readmissions and reoperations within 30 days of surgery was also higher among patients who had a TKA. However, the number of patients discharged home after surgery was higher among those who had a UKA (95.3% vs 81.6%).

In regression analyses, risk-adjusted models showed that compared to UKA patients, TKA patients had higher odds of having a blood transfusion (adjusted odds ratio [aOR], 19.74; 95% confidence interval [CI]: 8.19-47.60), major complications (aOR, 1.87; 95% CI: 1.27-2.77), minor complications (aOR, 1.43; 95% CI: 1.14-1.79), and 30-day readmissions (aOR, 1.41; 95% CI: 1.16-1.72) (Table 3 and Fig. 1). In addition, odds of a longer operation time (aOR, 7.72; 95% CI: 6.72-8.72) and in-hospital length of stay (aOR, 1.11; 95% CI: 1.05-1.17) were also higher for TKA patients than for UKA patients. Adjusted ORs for reoperation were not statistically significant (Fig. 1).

Discussion

This study examined perioperative and postoperative outcomes of patients with OA receiving either a TKA or UKA from 2014 to 2018, using data from the ACS-NSQIP. Our study identified statistically significant differences in age, gender, and ethnicity across both surgical procedure groups. We also found that the rates of complications, readmissions, and mortality were significantly higher among patients who received TKA.

Total operation time was significantly higher for TKA than for UKA. Similar findings were observed in other studies that showed that TKA required greater time for completing the procedure. For example, in a retrospective review that included 188 TKA and 106 UKA recipients, UKA required a shorter time for the procedure [21]. Similarly, in a matched paired study among 68 patients, the operation time for TKA (108.8 minutes) was significantly longer

Table 1
General characteristics of patient population.

Variables	Total (N = 274411)	TKA (n = 265519)	UKA (n = 8892)	*P* value
Age in years, mean ± SD	66.7 ± 9.5	66.8 ± 9.4	64.4 ± 10.4	<.001
Age group, no. (%)				<.001
<50	9815 (3.6)	9093 (3.4)	722 (8.1)	
50-64	99,714 (36.3)	96,009 (36.2)	3705 (41.7)	
65-79	140,478 (51.2)	136,662 (51.5)	3816 (42.9)	
≥80	24,404 (8.9)	23,755 (8.9)	649 (7.3)	
Sex, no. (%)				<.001
Female	167,861 (61.2)	163,395 (61.5)	4466 (50.2)	
Male	106,550 (38.8)	102,124 (38.5)	4426 (49.8)	
Race and ethnicity, no. (%)				<.001
Non-Hispanic white	184,032 (67.1)	177,691 (66.9)	6341 (71.3)	
Non-Hispanic black	19,868 (7.2)	19,607 (7.4)	261 (2.9)	
Hispanic	14,343 (5.2)	14,046 (5.3)	297 (3.3)	
Other/unknown	56,168 (20.5)	54,175 (20.4)	1993 (22.4)	
BMI (kg/m^2), mean ± SD	32.9 ± 7.0	32.9 ± 7.0	31.6 ± 6.3	<.001
Hypertension, no. (%)	97,597 (35.6)	93,699 (35.3)	3898 (43.8)	<.001
Diabetes, no. (%)				<.001
Insulin	12,093 (4.4)	11,744 (4.4)	349 (3.9)	
Noninsulin	37,871 (13.8)	36,844 (13.9)	1027 (11.5)	
Smoker, no. (%)	22,824 (8.3)	21,985 (8.3)	839 (9.4)	<.001
COPD, no. (%)	9503 (3.5)	9248 (3.5)	255 (2.9)	<.001
Steroid use, no. (%)	9689 (3.5)	9519 (3.6)	170 (1.9)	<.001
Bleeding disorders, no. (%)	5435 (2.0)	5287 (2.0)	148 (1.7)	<.001

BMI, body mass index; COPD, chronic obstructive pulmonary disease; SD, standard deviation.

Table 2
Perioperative and postoperative characteristics and outcomes.

Variables	Total (N = 274411)	TKA (n = 265519)	UKA (n = 8892)	*P* value
ASA class, no. (%)				<.001
1-No disturb	5165 (1.9)	4863 (1.8)	302 (3.4)	
2-Mild disturb	132,508 (48.3)	127,510 (48.0)	4998 (56.2)	
3-Severe disturb	131,813 (48.0)	128,317 (48.3)	3496 (39.3)	
4-Life threat	4600 (1.7)	4510 (1.7)	90 (1.0)	
5-Moribund	9 (0.0)	9 (0.0)	0 (0)	
None assigned	316 (0.1)	310 (0.1)	6 (0.1)	
ASA ≥3, no. (%)	136,422 (49.7)	132,836 (50.0)	3586 (40.3)	<.001
Anesthesia, no. (%)				<.001
Epidural	1957 (0.7)	1904 (0.7)	53 (0.6)	
General	121,652 (44.3)	117,767 (44.4)	3885 (43.7)	
Local	73 (0.0)	69 (0.0)	4 (0.0)	
MAC/IV sedation	36,422 (13.3)	35,214 (13.3)	1208 (13.6)	
None	55 (0.0)	54 (0.0)	1 (0.0)	
Other	214 (0.1)	201 (0.1)	13 (0.1)	
Regional	4953 (1.8)	4605 (1.7)	348 (3.9)	
Spinal	109,054 (39.7)	105,679 (39.8)	3375 (38.0)	
Unknown	31 (0.0)	26 (0.0)	5 (0.1)	
Total operation time (min), mean ± SD	89.9 ± 35.1	90.1 ± 35.1	84.6 ± 33.1	<.001
Length of stay (d), mean ± SD	2.5 ± 2.3	2.5 ± 2.3	1.4 ± 2.1	<.001
Any minor complications, no. (%)	6975 (2.5)	6826 (2.6)	149 (1.7)	<.001
Any major complications, no. (%)	3025 (1.1)	2972 (1.1)	53 (0.6)	<.001
Wound disruption, no. (%)	563 (0.2)	555 (0.2)	8 (0.1)	.014
Urinary tract infection, no. (%)	1903 (0.7)	1863 (0.7)	40 (0.4)	.004
Blood transfusions, no. (%)	5321 (1.9)	5300 (2.0)	21 (0.2)	<.001
DVT/Thrombophlebitis, no. (%)	1676 (0.6)	1649 (0.6)	27 (0.3)	<.001
Sepsis, no. (%)	503 (0.2)	491 (0.2)	12 (0.1)	<.001
Discharge disposition, no. (%)				<.001
Against medical advice	26 (0.0)	25 (0.0)	1 (0.0)	
Expired	88 (0.0)	88 (0.0)	0 (0)	
Home-based facility	1238 (0.5)	1216 (0.5)	22 (0.2)	
Home	225,156 (82.1)	216,687 (81.6)	8469 (95.3)	
Hospice	9 (0.0)	9 (0.0)	0 (0)	
Multilevel senior community	33 (0.0)	30 (0.0)	3 (0.0)	
Rehab	15,788 (5.8)	15,639 (5.9)	149 (1.7)	
Separate acute care	504 (0.2)	486 (0.2)	18 (0.2)	
Skilled care	31,237 (11.4)	31,017 (11.7)	220 (2.5)	
Unskilled facility	267 (0.1)	262 (0.1)	5 (0.1)	
Any readmission, no. (%)	8533 (3.1)	8342 (3.2)	191 (2.2)	<.001
Return to OR, no. (%)	3136 (1.1)	3053 (1.1)	83 (0.9)	<.001
Death, no. (%)	88 (0.0)	88 (0.0)	0 (0)	<.001

ASA, American Society of Anesthesiologists; DVT, deep venous thrombosis; MAC/ IV: monitored anesthesia care/ intravenous sedation; OR, operating room; SD, standard deviation.

Table 3
Results of risk-adjusted models of perioperative and postoperative outcomes of TKA compared to UKA.

Variable	aOR (95% CI)	*P* value
Blood transfusion	19.74 (8.19-47.60)	<.001
Operation time	7.72 (6.72-8.72)	<.001
Length of stay	1.11 (1.05-1.17)	<.001
Major complication	1.87 (1.27-2.77)	.002
Minor complication	1.43 (1.14-1.79)	.002
Unplanned reoperation	0.73 (0.48-1.12)	.154
Readmission	1.41 (1.16-1.72)	<.001

than that for UKA (51.5 minutes) [22]. In another retrospective review among 128 patients who were matched on demographic characteristics and Charlson Comorbidity Index, it was found that operative time was significantly longer for TKA than for UKA (112 minutes vs 81 minutes) [23]. In a retrospective study that included 105 TKA patients and 105 UKA patients, the mean operation time for TKA was 88 minutes while that for UKA was 67 minutes, and the significant differences in mean operation time were also evident here [24]. These studies along with ours demonstrate that UKA requires a shorter operative time, which results in shorter durations of anesthesia and a potentially lower risk of infection.

We also found that hospital length of stay was significantly greater for TKA than for UKA recipients. Although our data are recent, it is consistent with more historical studies demonstrating longer length of stay for TKA. Liddle et al. reported that hospital length of stay for patients undergoing TKA was 5.5 days and significantly longer than the length of stay for patients who had UKA, which was 4.1 days [25]. In addition, in a study that compared UKA and TKA at 9 orthopedic centers, the odds of hospital length of stay being >2 days was significantly greater for TKA than for UKA recipients [26]. Similar findings were reported by Lombardi et al., wherein the mean hospital length of stay for TKA was 2.2 days and significantly greater than that for UKA, which was 1.4 days [27]. During the last 2 decades, it has been adequately stressed that a significant reduction in hospital length of stay after arthroplasty could be achieved through improvements in thrombosis prevention, pain management, preoperative medical treatment, transfusion requirements, and surgical techniques [28]. These significant improvements have contributed towards decreasing hospital length of stay after arthroplasty. These rapid pathways have led to a recent surge in outpatient total knee replacements, which lagged behind outpatient unicompartmental knee replacements [29].

Our study also showed that readmission rates, major complications, minor complications, and requirements for blood transfusion were higher among TKA than among UKA recipients. In a study by Schwab et al. comprising 210 patients with OA who underwent surgical procedures, it was observed that the mean visible blood loss was significantly greater for TKA than for UKA, and conversely, postoperative hemoglobin levels were significantly lower for TKA than for UKA [24]. This study also showed that requirements for transfusion were higher among TKA patients than among UKA patients although not significantly different between the 2 groups [24]. In another study that compared TKA and UKA, blood loss and blood transfusion rates were significantly higher for TKA [30]. The widespread use of tranexamic acid in arthroplasty procedures is likely responsible for closing this gap. However, our study was unable to specifically evaluate this effect.

The more invasive nature of TKA (requiring more exposure of structures, soft-tissue dissection, and extensive bone cuts) could explain the findings of ours and other studies as it relates to perioperative complications and mortality. In a study that compared postoperative complications between UKA and TKA using Medicare data, it was found that the rates of wound complication, myocardial infarction, periprosthetic joint infection, pulmonary embolism, and stiffness were significantly higher among TKA recipients [31]. This study also showed that 30-day readmission rates were higher among TKA recipients. In addition, several complications such as pulmonary embolism, deep venous thrombosis, transfusion for anemia, stroke, cardiac decompensation, arrhythmia by atrial fibrillation, hematoma, deep infection, superficial infection, and bedsores were also significantly higher among TKA recipients [32]. It is important to emphasize that in addition to the foregoing complications, the differences in patient characteristics shown in our study may also have contributed to the differences in perioperative outcomes that we have observed.

The clinical presentation, radiological findings, and treatment objectives in a subset of patients make them suitable for both TKA and UKA procedures. Shared decision-making (SDM) between patients and their surgeons is an important process that can be instrumental in fashioning a suitable course of action for the care of the patient [14,33]. While the evaluation of SDM in TKA or UKA is beyond the scope of this research and qualitative data for its evaluation are not available in the NSQIP repository, it is entirely possible that SDM is at least in part responsible for the overwhelming differential of performed TKA vs UKA observed in our results. Our findings add to the body of evidence that emphasizes the merits of UKA compared to the TKA and that may help to enhance the SDM process.

Limitations

Our study has some limitations. We used NSQIP data for conducting a secondary analysis. This could have resulted in some surrogate information bias because the data were collected prior to the

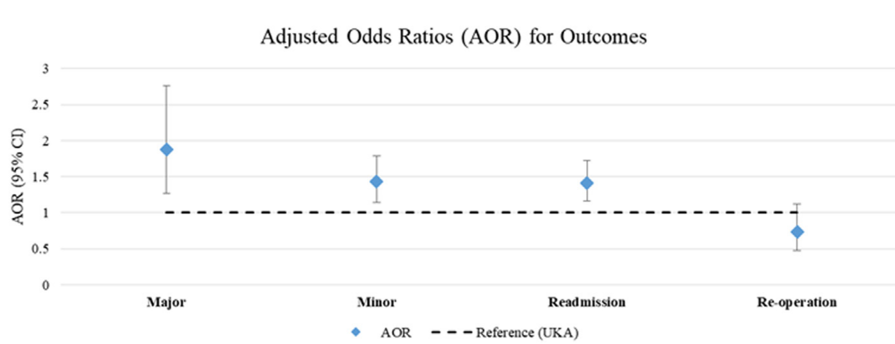

Figure 1. Adjusted odds ratios for major complications, minor complications, 30-day all-cause readmissions, and reoperation among patients undergoing TKA and UKA procedures, NSQIP (2014-2018).

current study, and there may be confounding factors, which we may have been unable to identify, ascertain, or control for due to the retrospective nature of the current study. We used Current Procedural Terminology codes for identifying patients who received TKA and UKA. This could have led to coding errors leading to misclassification bias, which could have affected our study's findings.

The NSQIP database does not have information about the radiographic staging of OA in preoperative diagnosis. Therefore, it was not possible to determine the severity of OA prior to the procedure, nor could we determine whether the OA was limited to a single compartment or more widespread throughout the joint. Such information could have improved our estimates and enhanced the interpretation of results in our study. However, our regression models are robust and account for every variable available in the data that can influence the outcomes of interest in this study.

The NSQIP data do not have information on specific orthopedic outcomes such as pain, short-term functionality, and stiffness, and as such, we were unable to assess these important outcomes. In addition, because the NSQIP database is limited to 30 days after surgery, we are unable to assess longer-term outcomes of joint functionality or revision surgeries.

This study compares outcomes of 2 groups of patients that have statistically significant differences in their demographic characteristics and had 2 distinct procedures, and although we found significantly better outcomes with the UKA vs TKA, these results should be interpreted with caution.

Conclusions

Our study results demonstrate that risk-adjusted adverse events during the initial postoperative period were higher among patients who had a TKA than among those who had a UKA. By directly comparing the 2 treatments, this study demonstrates better results for UKA in several acute outcome domains. These findings support the safety of UKA for patients that meet clinical criteria for the procedure. For those patients whose clinical presentation makes them eligible for either a TKA or a UKA, our findings offer useful evidence that can aid decision-making for selection of surgical options. There is a need for more studies that compare outcomes for both UKA and TKA in patients who are specifically eligible for either procedure based on clinical picture and goals of care, both for the short-term and long-term postoperative period.

Conflict of interest

Dr. Suarez receives royalties from Corin USA, is in the speakers' bureau of or gave paid presentations for Depuy, is a paid consultant for Depuy, and has stock or stock options in Cuptimize. All other authors declare no potential conflicts of interest.

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