

Investigating Short-term Outcomes and Healthcare Utilization After Traditional Versus Computer-assisted Total Knee Arthroplasty

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The purpose of this study was to compare the incidence of various short-term complications and healthcare utilization between traditional and computer-assisted total knee arthroplasty (CA-TKA). Traditional TKA and CA-TKA cases were extracted from the American College of Surgeons' National Surgical Quality Improvement Program. Patients were matched using patient and demographic variables. Outcomes were compared between the two patient groups after exact matching. Multivariate logistic regression was performed to identify independent risk factors for various outcome measures. The authors identified 159,521 patients that underwent traditional TKA and 3,464 patients that underwent CA-TKA. After matching, CA-TKA patients were more likely to have a nonhome discharge and a hospital length of stay greater than 2 days. Other outcome measures—readmission, reoperation, mortality, and surgical/medical complications—were comparable between groups. Patients undergoing computer-assisted TKA were more likely to have a nonhome discharge and a hospital length of stay greater than 2 days. (Journal of Surgical Orthopaedic Advances 34(3):156-160, 2025)

Key words: computer-assisted total knee arthroplasty (CA-TKA), short-term outcomes, healthcare utilization, ACS NSQIP

Total knee arthroplasty (TKA) is the most common operative treatment for end-stage osteoarthritis of the knee.¹ It has been predicted that the demand for TKA will increase to nearly 3.5 million procedures by the year 2030 due to the aging population.² Driving the popularity of TKA are the high rates of patient satisfaction and low rates of postoperative complications following replacement. Despite a low complication rate, there has been a constant effort made to improve alignment intraoperatively with high rates of repeatability.³ The use of computer assistance (CA) offers a potential solution by measuring resection thickness, joint gaps, and limb alignment intraoperatively.^{4,5}

Since CA was introduced to TKA in the late 1990s, there is inconclusive evidence over whether this reproducibility and increased accuracy in alignment improve clinical patient outcomes. Some studies have found that CA-TKA have improved postoperative range of motion and implant survival compared with traditional TKA.⁶ Other studies have found that CA-TKA does not improve revision rates or implant loosening, reduce pain, or increase range of motion compared with the traditional procedure.^{7,8}

Many of the current studies used to compare these two procedures have small sample sizes, so a larger database study offers the potential to increase the statistical power and compare several rarer preoperative characteristics and postoperative complications between the two procedures. The American College of Surgeons' (ACS) National Surgical Qual-

ity Improvement Program (NSQIP) database offers a solution by tracking many patient characteristics and follows patients for 30 days postoperatively from over 700 hospitals across the United States.⁹

At this time, two previous studies have attempted to compare the outcomes of traditional TKA and CA-TKA using this large database, but these studies have significant drawbacks. Aoude et al.¹⁰ first investigated this topic using a database in 2016 and found that the use of CA in TKA reduced the number of total adverse events in the first 30 days postoperatively. However, CA-TKA was associated with an increased number of reoperations. This study has flaws that call into question its assertions. The authors examined procedures from 2011 to 2013, limiting the available sample size. Additionally, the authors lacked propensity score matching or exact matching to compare the CA-TKA with the traditional TKA. Gholson et al.¹¹ later investigated this topic in 2017 and found that there were no significant differences in short-term complications, readmission rate, or length of stay between navigated and traditional TKA. However, this study included data from 2010–2014 and compared complications in each year individually, thus lowering the total statistical power of the study.

The purpose of this study is to combine the large sample size and statistical power of database analysis with current data and accurate statistical matching to determine whether there exist differences in the short-term outcomes and healthcare utilization after traditional TKA versus CA-TKA.

Methods and Materials

Data Source and Extraction

Traditional and computer-assisted TKA cases performed between January 1, 2015, and December 31, 2017, were extracted from the American College of Surgeons' (ACS)-NSQIP database. The ACS-NSQIP database includes more than 700 participant institutions nationally with a validated clinical reviewer inputting various measures from a patient's chart as well as postoperative outcomes. These data are validated and deidentified for research purposes.

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Current procedural terminology (CPT) primary and modifier codes were used to identify and stratify patients undergoing traditional and CA-TKAs. The primary CPT code utilized for this study was 27447. Supplemental CPT codes 20985, 0054T, and 0055T were used to identify computer-assisted TKA cases. Only primary TKAs were included in this study. Patients were excluded if they were under the age of 18 or had incomplete data. Patients were divided into two groups based on the type of TKA they underwent. The full comparison of preoperative characteristics between the two cohorts is outlined in Table 1.

TABLE 1. Baseline patient demographic variables prior to matching

	Traditional TKA (n = 159,521)	CA-TKA (n = 3,464)	p-Value
Sex			
Male	61,292 (38.4%)	2,087 (60.2%)	0.112
Female	98,229 (61.6%)	1,377 (39.8%)	
Age			
18 – 40 years	539 (0.3%)	5 (0.1%)	0.051
40 – 49 years	4,835 (3.0%)	100 (2.9%)	0.624
50 – 59 years	29,816 (18.7%)	672 (19.4%)	0.290
60 – 69 years	62,145 (39.0%)	1,358 (39.2%)	0.769
70 – 79 years	48,076 (30.1%)	1,038 (30.0%)	0.827
80 + years	14,110 (8.8%)	291 (8.4%)	0.341
BMI (kg/m ²)			
Underweight	872 (0.5%)	14 (0.4%)	0.259
Normal	14,553 (9.1%)	311 (9.0%)	0.770
Overweight	42,353 (26.6%)	924 (26.7%)	0.870
Obese Class I	46,205 (29.0%)	1,003 (29.0%)	0.990
Obese Class II	31,603 (19.8%)	711 (20.5%)	0.301
Obese Class III	23,935 (15.0%)	501 (14.5%)	0.337
Comorbidities			
Diabetes	29,413 (18.4%)	560 (16.2%)	0.001
Smoking	13,296 (8.3%)	262 (7.6%)	0.104
COPD	5,647 (3.5%)	111 (3.2%)	0.290
Ascites	28 (0.0%)	0 (0.0%)	> 0.999
Congestive heart failure	492 (0.3%)	4 (0.1%)	0.041
Hypertension	103,666 (65.0%)	2,328 (67.2%)	0.007
Renal failure	36 (0.0%)	0 (0.0%)	> 0.999
Dialysis	263 (0.2%)	0 (0.0%)	0.008
Bleeding disorder	3,135 (2.0%)	59 (1.7%)	0.271
Chronic steroid use	5,664 (3.6%)	116 (3.3%)	0.525
ASA Class			
Class 1 (No disturbance)	2,909 (1.8%)	25 (0.7%)	< 0.001
Class 2 (Mild disturbance)	76,422 (47.9%)	1,607 (46.4%)	0.077
Class 3 (Severe disturbance)	77,288 (48.5%)	1,769 (51.1%)	0.002
Class 4 + (Life threatening)	2,712 (1.7%)	59 (1.7%)	0.989
Functional Status			
Independent	156,976 (98.4%)	3,444 (99.4%)	< 0.001
Partially dependent	1,664 (1.0%)	19 (0.5%)	0.004
Totally dependent	52 (0.0%)	1 (0.0%)	> 0.999
Not reported	0 (0.0%)	0 (0.0%)	-

Bold indicates statistical significance

TKA, total knee arthroplasty; CA, computer assistance; BMI, body mass index; COPD, chronic obstructive pulmonary disease; ASA, American Society of Anesthesiologists

Outcome Measures

Outcomes measures in the NSQIP database were reported within 30 days postoperatively. The outcome measures of interest were unplanned hospital readmission, reoperation, nonhome discharge, length of stay greater than 2 days, mortality, and various medical and surgical complications. Medical complications included pneumonia, wound infection, failure to wean intubation, reintubation, deep venous thromboembolism, pulmonary embolism, urinary tract infection, renal insufficiency, renal failure, myocardial infarction, cardiac arrest, cerebrovascular accident, systemic sepsis, and septic shock. Surgical complications included dehiscence, superficial and deep surgical site infection, and bleeding (e.g., requiring transfusion).

Patient Variables and Risk Factors

Patient variables of interest included sex, age, body mass index (BMI), American Society of Anesthesiologists (ASA) classification score, functional status, and various medical comorbidities: diabetes, chronic obstructive pulmonary disease (COPD), ascites, congestive heart failure (CHF), hypertension, dialysis, renal failure, bleeding disorders, and chronic steroid use.

Cohort Matching

Exact matching was used to control for differences between the TKA and CA-TKA populations. Patients in the CA-TKA cohort were matched to patients in the group based on the aforementioned variables of interest. The incidence of various 30-day complications were compared between the matched groups.

Statistical Analysis

Descriptive statistics were performed to summarize patient characteristics. Chi-squared and unpaired t-tests were used to compare the previously discussed categorical and continuous predictor variables, respectively, between traditional TKA and CA-TKA groups prior to and after exact matching. Univariate binary logistic regressions were used to estimate the risk ratio and 95% confidence interval for variables of interest. Variables were included in the univariate regression if there was a trend toward a significant difference in the chi-squared or unpaired t-tests described previously ($p < 0.20$). The variables that were found to be significant predictors within the univariate regression were subsequently incorporated into a multivariate binary logistic regression performed in the CA-TKA cohort to identify independent risk factors for various 30-day outcome measures. Statistical significance was defined as $p < 0.05$ for all analyses. All statistical tests were performed with IBM SPSS Version 24.0 (Armonk, NY: IBM Corp).

Results

Prior to matching, 159,521 patients underwent traditional TKA and 3,464 patients underwent CA-TKA. There were various significant differences between the TKA and CA-TKA cohort among medical comorbidities, ASA classifications, and functional status. In terms of outcomes, the TKA and CA-TKA groups had significant differences in proportion of nonhome discharge and length of stay more than 2 days. The complete comparisons are outlined in Tables 1 and 2.

TABLE 2. 30-day outcome measures prior to matching

	Traditional TKA (n = 159,521)	CA-TKA (n = 3,464)	p-Value
Unplanned Readmission	5,118 (3.2%)	100 (2.9%)	0.288
Reoperation	1,844 (1.2%)	32 (0.9%)	0.205
Nonhome Discharge	30,002 (18.8%)	801 (23.1%)	< 0.001
Length of Stay > 2 days	69,107 (43.3%)	1,628 (47.0%)	< 0.001
Mortality	159 (0.1%)	5 (0.1%)	0.405
Surgical Complications			
Overall	4,174 (2.6%)	74 (2.1%)	0.079
Superficial surgical site infection	809 (0.5%)	12 (0.3%)	0.411
Deep surgical site infection	321 (0.2%)	6 (0.2%)	0.913
Dehiscence	324 (0.2%)	6 (0.2%)	0.898
Bleeding	2,678 (1.7%)	49 (1.4%)	0.476
Medical Complications			
Overall	4,014 (2.5%)	78 (2.3%)	0.325
Wound infection	173 (0.1%)	2 (0.1%)	0.595
Pneumonia	519 (0.3%)	7 (0.2%)	0.443
Reintubation	214 (0.1%)	4 (0.1%)	0.918
Failure to wean intubation	90 (0.1%)	4 (0.1%)	0.152
Pulmonary embolism	796 (0.5%)	10 (0.3%)	0.217
Renal insufficiency	166 (0.1%)	3 (0.1%)	0.944
Renal failure	83 (0.1%)	1 (0.0%)	> 0.999
Urinary tract infection	1,125 (0.7%)	14 (0.4%)	0.209
Cerebrovascular accident	133 (0.1%)	4 (0.1%)	0.542
Cardiac arrest	110 (0.1%)	1 (0.0%)	0.839
Myocardial infarction	298 (0.2%)	7 (0.2%)	0.942
Deep venous thromboembolism	1,191 (0.7%)	34 (1.0%)	0.237
Systemic sepsis	279 (0.2%)	4 (0.1%)	0.536
Septic shock	76 (0.0%)	0 (0.0%)	0.415

Bold indicates statistical significance

TKA, total knee arthroplasty; CA, computer assistance; BMI, body mass index; COPD, chronic obstructive pulmonary disease

After exact matching, each cohort had 3,437 patients; the cohort comparison is outlined in Table 3. After exact matching, there were no statistically significant differences across any of the aforementioned demographic variables by group. There was, however, a statistically significant higher incidence of nonhome discharge and length of stay longer than 2 days in the CA-TKA group compared with the traditional TKA group. The full comparison is outlined in Table 4. Additionally, there was a statistically higher operative time, length of stay, total relative value units (RVUs), RVUs/minute, total reimbursement, and reimbursement/min in the CA-TKA group compared with the traditional TKA group. The full analysis can be found in Table 5.

A multivariate regression was completed within the CA-TKA group to determine the risk factors for multiple postoperative complications. Within this group, significant associations were found for unplanned readmission, nonhome discharge, length of stay greater than 2 days, surgical complications, and medical complications. The complete list of significant associations is summarized in Table 6.

Discussion

There is inconsistent evidence to determine whether CA-TKA offers any advantage over traditional TKA regarding postoperative complications and overall patient satisfaction.

TABLE 3. Comparing patient demographic variables after exact matching

	Traditional TKA (n = 3,437)	CA-TKA (n = 3,437)	p-Value
Sex			
Male	1,362 (39.6%)	1,362 (39.6%)	> 0.999
Female	2,075 (60.4%)	2,075 (60.4%)	
Age			
18 – 40 years	5 (0.1%)	5 (0.1%)	> 0.999
40 – 49 years	96 (2.8%)	96 (2.8%)	> 0.999
50 – 59 years	666 (19.4%)	666 (19.4%)	> 0.999
60 – 69 years	1,354 (39.4%)	1,354 (39.4%)	> 0.999
70 – 79 years	1,031 (30.0%)	1,031 (30.0%)	> 0.999
80 + years	285 (8.3%)	285 (8.3%)	> 0.999
BMI (kg/m ²)			
Underweight	13 (0.4%)	13 (0.4%)	> 0.999
Normal	308 (9.0%)	308 (9.0%)	> 0.999
Overweight	917 (26.7%)	917 (26.7%)	> 0.999
Obese Class I	996 (29.0%)	996 (29.0%)	> 0.999
Obese Class II	707 (20.6%)	707 (20.6%)	> 0.999
Obese Class III	496 (14.4%)	496 (14.4%)	> 0.999
Comorbidities			
Diabetes	553 (16.1%)	553 (16.1%)	> 0.999
Smoking	253 (7.4%)	253 (7.4%)	> 0.999
COPD	102 (3.0%)	102 (3.0%)	> 0.999
Ascites	0 (0.0%)	0 (0.0%)	> 0.999
Congestive heart failure	1 (0.0%)	1 (0.0%)	> 0.999
Hypertension	2,313 (67.3%)	2,313 (67.3%)	> 0.999
Renal failure	0 (0.0%)	0 (0.0%)	> 0.999
Dialysis	0 (0.0%)	0 (0.0%)	> 0.999
Bleeding disorder	50 (1.5%)	50 (1.5%)	> 0.999
Chronic steroid use	109 (3.2%)	109 (3.2%)	> 0.999
ASA Class			
Class 1 (No disturbance)	25 (0.7%)	25 (0.7%)	> 0.999
Class 2 (Mild disturbance)	1,603 (46.6%)	1,603 (46.6%)	> 0.999
Class 3 (Severe disturbance)	1,754 (51.0%)	1,754 (51.0%)	> 0.999
Class 4 + (Life threatening)	53 (1.5%)	53 (1.5%)	> 0.999
Functional Status			
Independent	3,423 (99.6%)	3,423 (99.6%)	> 0.999
Partially dependent	14 (0.4%)	14 (0.4%)	> 0.999
Totally dependent	0 (0.0%)	0 (0.0%)	> 0.999
Not reported	0 (0.0%)	0 (0.0%)	> 0.999

TKA, total knee arthroplasty; CA, computer assistance; BMI, body mass index; COPD, chronic obstructive pulmonary disease

This study aimed to determine whether there is a difference in the 30-day complication rates between the two procedures when comparing appropriately matched patient groups. To the authors' knowledge, this study is the first to use a database to complete an accurately matched and appropriately powered study investigating the short-term complications following traditional TKA and CA-TKA.

The risk factors for various complications following CA-TKA were similar to those previously found for traditional TKA, such as diabetes, higher ASA class, older age, obesity, and COPD.¹²⁻¹⁴ Additionally, surgical complications, medical complications, mortality, reoperation, and unplanned readmission occurred at similar rates in both traditional and CA-TKA groups. Other studies have similarly found no difference in the short-term complications between the CA-TKA group and the conventional TKA group.^{15,16}

When the two groups were matched, this study found that the CA-TKA group had a statistically higher incidence of nonhome discharge and hospital stay longer than 2 days.

TABLE 4. Comparing 30-day outcome measures after exact matching between traditional and CA-TKA

	Traditional TKA (n = 3,437)	CA-TKA (n = 3,437)	p-Value
Unplanned Readmission	111 (3.2%)	97 (2.8%)	0.324
Reoperation	38 (1.1%)	32 (0.9%)	0.471
Nonhome Discharge	561 (16.3%)	790 (23.0%)	< 0.001
Length of Stay > 2 days	1,170 (34.0%)	1,611 (46.9%)	< 0.001
Mortality	0 (0.0%)	5 (0.1%)	0.062
Surgical Complications			
Overall	64 (1.9%)	73 (2.1%)	0.437
Superficial surgical site infection	15 (0.4%)	11 (0.3%)	0.432
Deep surgical site infection	7 (0.2%)	6 (0.2%)	0.781
Dehiscence	2 (0.1%)	6 (0.2%)	0.289
Bleeding	35 (1.0%)	49 (1.4%)	0.124
Medical Complications			
Overall	99 (2.9%)	76 (2.2%)	0.078
Wound infection	6 (0.2%)	2 (0.1%)	0.289
Pneumonia	13 (0.4%)	6 (0.2%)	0.222
Reintubation	7 (0.2%)	4 (0.1%)	0.387
Failure to wean intubation	2 (0.1%)	4 (0.1%)	0.687
Pulmonary embolism	18 (0.5%)	10 (0.3%)	0.130
Renal insufficiency	3 (0.1%)	3 (0.1%)	> 0.999
Renal failure	4 (0.1%)	1 (0.0%)	0.375
Urinary tract infection	27 (0.8%)	14 (0.4%)	0.099
Cerebrovascular accident	2 (0.1%)	4 (0.1%)	0.687
Cardiac arrest	1 (0.0%)	1 (0.0%)	> 0.999
Myocardial infarction	9 (0.3%)	7 (0.2%)	0.617
Deep venous thromboembolism	37 (1.1%)	33 (1.0%)	0.357
Systemic sepsis	12 (0.3%)	4 (0.1%)	0.076
Septic shock	4 (0.1%)	0 (0.0%)	0.125

Bold indicates statistical significance

CA, computer assistance; TKA, total knee arthroplasty

TABLE 5. Operative and perioperative factors

	Traditional TKA (n = 3,437)	CA-TKA (n = 3,437)	p-Value
Total Operative Time (min)	90.9 ± 35.4	93.0 ± 34.4	0.015
Operative Time Over 120 Minutes	567 (16.5%)	578 (16.8%)	0.722
Length of Stay (Days)	2.3 ± 2.9	2.6 ± 2.7	< 0.001
Total RVU	20.7 ± 0.2	23.2 ± 0.4	< 0.001
RVU/min	0.261 ± 0.196	0.278 ± 0.156	< 0.001
Total Reimbursement (U.S. Dollars)	747.05 ± 7.22	837.28 ± 14.44	< 0.001
Reimbursement/min (U.S. Dollars/min)	9.41 ± 7.07	10.03 ± 5.63	< 0.001

Bold indicates statistical significance

TKA, total knee arthroplasty; CA, computer assistance;

RVU, relative value units; U.S., United States

Interestingly, nonhome discharge (discharge to facilities such as nursing homes or skilled nursing facilities) has not previously been found to be associated with CA-TKA to the authors' knowledge. It is possible that the longer length of the procedure is contributing to the higher incidence of

TABLE 6. Multivariate logistic regression to identify risk factors for various 30-day complications in the propensity-score matched CA-TKA group

	LR [95% C.I.]
Unplanned Readmission	
Age 80 + years old	2.026 [1.148 – 3.577]
Hx of COPD	3.957 [1.985 – 7.887]
Reoperation	–
Nonhome Discharge	
Male	0.562 [0.469 – 0.673]
Age	
60 – 70 years	1.811 [1.377 – 2.382]
70 – 80 years	4.447 [3.378 – 5.855]
80 + years	10.893 [7.731 – 15.346]
BMI Class	
Obesity Class II	1.298 [1.044 – 1.613]
Obesity Class II	1.660 [1.290 – 2.135]
Diabetes	1.438 [1.156 – 1.789]
COPD	1.659 [1.065 – 2.583]
Bleeding Disorder	2.186 [1.189 – 4.020]
Length of Stay > 2 Days	
Male	0.589 [0.510 – 0.681]
Age	
60 – 70 years	2.027 [1.037 – 1.519]
70 – 80 years	2.027 [1.654 – 2.485]
80 + years	3.945 [2.899 – 5.367]
BMI	
Obesity Class I	0.786 [0.673 – 0.919]
ASA Class	
Score 3 +	1.768 [1.524 – 2.051]
Diabetes	1.235 [1.015 – 1.503]
Smoking	0.710 [0.535 – 0.941]
Hypertension	0.765 [0.652 – 0.899]
Mortality	–
Surgical Complications	
ASA Class	
Score 4	5.230 [2.013 – 13.589]
BMI	
Obesity Class I +	0.607 [0.380 – 0.967]
Medical Complications	
Diabetes	1.981 [1.159 – 3.384]
Functional Status	
Independent	0.129 [0.028 – 0.604]

CA, computer assistance; TKA, total knee arthroplasty;

LR, logistic regression; CI, confidence interval; Hx, history;

COPD, chronic obstructive pulmonary disease; BMI, body mass

index; ASA, American Society of Anesthesiologists

nonhome discharge that has been previously found for conventional major joint arthroplasty. It is also possible that the average longer length of stay in the CA-TKA group could be contributing to the nonhome discharge. Ramkumar et al.¹⁷ previously found an independent association between longer hospital stays and nonhome discharge. Higher rates of nonhome discharge have clinical relevance, as it is associated with an increased rate of readmission to the hospital in the 90 days following major joint arthroplasty.¹⁸ Unsurprisingly, discharge to a nonhome location incurs higher costs and increased rates of adverse events.^{19,20}

This study found a statistically significant increase in the number of stays longer than 2 days in the hospital and average length of stay following CA-TKA compared with traditional TKA. In this study, nearly 450 (13%) of patients were found to have a length of stay greater than 2 days in the CA-TKA group (1,611 CA-TKA patients vs. 1,170 TKA patients). This is likely to

have significant clinical implications if a patient is nearly 40% more likely to stay in the hospital longer than 2 days. Each extra day in a Level I Trauma Center following orthopaedic procedures has an estimated increased cost of \$2,000.²¹ Aside from the increased cost, increased length of stay has been found to be an independent predictor of readmission following total joint arthroplasty, an important quality metric.²²

This study is not without its own limitations. The NSQIP database follows patients for 30 days postoperatively and limits the authors' ability to evaluate for long-term complications. Additionally, NSQIP fails to capture case complexity or measures of preoperative deformity. These factors do change surgeon approach regarding TKA. Finally, the retrospective nature of this study limits its predictive value. Further randomized controlled studies evaluating traditional TKA compared with CA-TKA should be performed to elucidate the validity of these findings.

To the authors' knowledge, this is the first study with both exact matching and high statistical power to comment on the complication rates and differences following CA-TKA and traditional TKA. This study found similar rates of medical and surgical complications, unplanned readmission, reoperation, and mortality. However, this study also found a statistically higher incidence of length of stay > 2 days and nonhome discharge in the CA-TKA group. These factors contribute to higher costs to the healthcare system and increased adverse outcomes for patients. These findings can help guide clinician decision-making regarding the optimal treatment in the case of a patient eligible for both procedures.

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