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Thirty-Day Complications of Conventional and Computer-Assisted Total Knee and Total Hip Arthroplasty: Analysis of 103,855 Patients in the American College of Surgeons National Surgical Quality Improvement Program Database

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ABSTRACT

Background: Computer-assisted surgery (CAS) has gained popularity in orthopedics for both total knee arthroplasty (TKA) and total hip arthroplasty (THA) in the past decades.
Methods: The American College of Surgeons National Surgical Quality Improvement Program database was used to identify patients who underwent a primary, unilateral THA and TKA from 2011 to 2013. Multivariate analysis was conducted to compare the postoperative complications in patients whose surgery involved the use of CAS with those by conventional techniques.
Results: We identified 103,855 patients who had THA and TKA in the database between 2011 and 2013. There were higher overall adverse events (odds ratio [OR], 1.40; CI, 1.22-1.59), minor events (OR, 1.38; CI, 1.21-1.58), and requirements for blood transfusion (OR, 1.44; CI, 1.25-1.67) in the conventional group when compared with CAS for TKA. However, rate of reoperation was higher in the CAS group for TKA (OR, 1.60; CI, 1.15-2.25). The results also showed higher overall adverse events (OR, 2.61; CI, 2.09-3.26), minor events (OR, 2.82; CI, 2.24-3.42), and requirements for blood transfusion (OR, 3.41; CI, 2.62-4.44) in the conventional group when compared to CAS for THA. Nevertheless, superficial wound infections (OR, 0.46; CI, 0.26-0.81) were shown to be higher in the CAS group undergoing THA.
Conclusion: The use of CAS in THA and TKA reduced the number of minor adverse events in the first 30 days postoperatively. However, CAS was associated with an increased number of reoperations and superficial infections. The clinical benefits and disadvantages of CAS should be considered when determining the potential benefit—cost ratio of this technology.

Many new technologies have been developed in orthopedic surgery to help surgeons achieve better accuracy of implant placement. These include robotic surgery [1], patient-specific instruments [2], and computer-assisted surgery (CAS). CAS has gained popularity in orthopedics for both total knee arthroplasty (TKA) and total hip arthroplasty (THA) in the past decade [3] as a stereotactic device [4] that provides the surgeon with real-time feedback on implant position based on electromagnetic or infrared-based instruments.

The aim of CAS in arthroplasty surgery is to improve implant position because appropriate implant position has been shown to be associated with improved survivorship for both TKA [3,5] and THA [6,7]. Sharkey et al [8] showed that 50% of revision TKA was because of implant malpositioning. Early TKA failure has been shown to be related to mechanical axis outside 3° [9,10]. Therefore, this has become a common target of alignment for TKA for both conventional and CAS techniques. Similarly, in hip arthroplasty, acetabular malposition has been shown to be an important cause for dislocation

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and accelerated wear [6,7]. Lewinnek et al [11] showed that the safe zone for acetabular positioning is an inclination of 40° ± 10° and anteversion of 15° ± 10°. These values are commonly used for adequate acetabular component positioning in conventional and CAS techniques. Multiple studies have shown that CAS improves alignment in both TKA and THA and reduces outliers [12-14]; however, few studies have adequately proven the clinical benefit of CAS [14].

An important consideration of the clinical impact of CAS is the rate of postoperative complications in comparison to standard or conventional techniques. Only a few studies have been published in the literature, which look specifically at complications in patients treated with CAS in THA [15-17] and TKA [14,18]. These studies looked at small groups of patients and found no statistically significant difference. However, it is unclear if these findings clarify this issue or merely reflect the statistical power in these underpowered studies. Therefore, the aim of this study was to compare 30-day postoperative complications in a large cohort of patients who underwent THA and TKA using either conventional surgical techniques or CAS.

Material and Methods

Database Source and Patient Selection

We analyzed the data from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database between 2011 and 2013 for THA and TKA patients. The database includes over 130 variables for each patient, which include patient demographics, preoperative laboratory results, comorbidities, procedure type, intraoperative variables such as length of surgery, and 30-day postoperative complications. The database captures information from over 400 hospitals across the United States and Canada. In addition, the data acquisition has been validated in the literature [19,20] and is monitored to ensure consistency of data. All patients who had THA and TKA between 2011 and 2013 were identified via Current Procedural Terminology codes: 27447 for TKA and 27130 for THA. Patients who underwent CAS were identified using the following Current Procedural Terminology codes: 20985, 0055T, and 0054T. Patients who underwent revision surgery, emergent surgery, hemiarthroplasty, bilateral TKA, unicondylar knee arthroplasty, and patients who underwent other or concurrent procedures were excluded from the analysis. Patients who had a principle diagnosis of hip fracture were excluded as well.

Patient Characteristics and Outcomes Variables

The main outcome of this study was 30-day postoperative complications after THA or TKA. The complications were divided into 2 categories: minor adverse events and major adverse events. Minor events were defined as deep vein thrombosis, blood transfusion, superficial wound infection, urinary tract infection, and pneumonia, whereas major events were defined as myocardial infarction, cardiac arrest, sepsis, pulmonary embolism, stroke, unplanned intubation, deep wound infection, and ventilator requirement for more than 48 hours.

To control for confounders, patient's demographics, comorbidities, and clinical characteristics were extracted from the database. Captured demographics included age, gender, and race. Comorbidities included body mass index, diabetes (recorded as history of type 1 or type 2 diabetes), smoking, dyspnea (classified as dyspnea at rest or at moderate excretion), chronic obstructive pulmonary disease, congestive heart failure, dialysis, hypertension, bleeding disorder, steroids intake for chronic diseases, functional health status before surgery, and American Society of Anesthesiologist class. Clinical variables were operative time, readmission, and reoperation.

Statistical Analysis

All statistical analyses were conducted using SPSS, version 21 (IBM Corp, Armonk, NY). Student *t* tests for continuous variable and Pearson chi-square for categorical variables were used to compare patient demographic and preoperative clinical characteristics between patients who underwent TKA and THA via conventional techniques or CAS. Multivariate logistic regression was conducted to compare the occurrence of complications between patients who had surgery using the 2 different techniques. Multivariate linear regression was used to assess the effect of surgical technique on operative time and hospital length of stay. All multivariate analyses controlled for demographic and comorbidity variables included in Table 1 for TKA and Table 2 for THA.

Results

We identified 103,855 patients who had TKA (62,273 patients) and THA (41,582 patients) procedures in the database between

Table 1
Demographics and Clinical Characteristics of Patients Who Underwent Total Knee Arthroplasty.

Patient and Clinical Characteristics	Total Knee Arthroplasty			
	All Patients (N = 62,273)	Conventional Technique (N = 60,100)	Computer Assisted (N = 2173)	*P* Value
Demographic characteristics				
Age (y)	67.18 ± 9.83	67.20 ± 9.9	67.20 ± 1.0	.94
Gender (%)				.75
Woman	62.9	62.9	63.3	
Men	37.1	37.1	36.7	
Race (%)				**<.001**
White	89.4	89.2	92.2	
Black or African American	7.3	7.3	6.6	
Asian	2.5	2.6	1.0	
American Indian or Native	0.5	0.5	0.1	
Native Hawaiian or Pacific Islander	0.4	0.4	0.1	
Comorbidities				
BMI (kg/m^2)	32.81 ± 7.10	32.81 ± 7.1	32.50 ± 7.3	**.03**
Diabetes (%)				**.03**
Type I	4.3	4.3	3.6	
Type II	13.3	13.3	14.9	
Smoking (%)	8.2	8.2	8.0	.689
Dyspnea (%)				
At rest	0.2	0.2	0.7	**<.001**
Moderate exertion	6.5	6.5	6.7	
COPD (%)	3.5	3.5	4.5	**.018**
CHF (%)	0.2	0.2	0.4	.111
Dialysis (%)	0.1	0.1	0.1	.983
Hypertension (%)	66.3	66.2	69.5	**.001**
Bleeding disease (%)	2.7	2.7	2.3	.176
Steroids (%)	3.3	3.3	2.8	.163
ASA class (%)				.64
1	2.2	2.2	1.7	
2	51.3	51.3	51.8	
3	44.9	44.9	44.8	
4	1.6	1.6	1.7	
Clinical Characteristics				
Operation time (min)	92.70 ± 36.54	92.60 ± 36.62	94.40 ± 33.50	**.02**
Readmission	4.5	4.4	5.2	.478
Reoperation	1.1	1.1	1.6	**.007**

Values in boldface indicate statistical significance ($P < .05$).
ASA, American Society of Anesthesiologist; BMI, body mass index; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.