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ORIGINAL ARTICLE

An Analysis of Risk Factors for Short-Term Complication Rates and Increased Length of Stay Following Unicompartmental Knee Arthroplasty

Bryan D. Haughom, MD · William W. Schairer, MD · Michael D. Hellman, MD · Benedict U. Nwachukwu, MD · Brett R. Levine, MD, MS

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Abstract *Background:* Unicompartmental knee arthroplasty (UKA) is an increasingly popular procedure, with excellent long-term outcomes. However, there are only a limited number of reports reporting its short-term morbidity and mortality. *Questions/Purposes:* We sought to analyze the reported 30-day morbidity, mortality, and risk factors for complications and prolonged length of stay (>4 days) following UKA. *Patients and Methods:* Utilizing the National Surgical Quality Improvement Program (NSQIP) database, including patients (n=2316) from 2005–2012, we correlated the reported 30-day complications and prolonged length of stay with patient demographics and risk factors. *Results:* The overall rate of complications was low (3.2%). The distribution of complications demonstrated 0.5% major systemic, 1.4% minor systemic, 0.7% major local, and 0.9% minor local complications, with a 2.1% readmission rate. Multivariate regression demonstrated increased BMI and a history of chronic obstructive pulmonary disease (COPD) as independent risk factors for complications. Furthermore, multivariate regression demonstrated increased BMI, ASA≥3, history of COPD, recent operation, and postoperative transfusion as independent risk factors for prolonged length of hospitalization. *Conclusions:* Utilizing the NSQIP, we present one of the largest studies to date evaluating complications following UKA. Our multivariate model demonstrated obesity and COPD to be the risk factors for complications while obesity, ASA≥3, COPD, recent operation, and blood transfusion to be the risk factors for prolonged length of stay.

Keywords Unicompartmental Knee Arthroplasty · NSQIP · Short-Term · Complications · COPD · Obesity · Transfusion

Level of Evidence: Prognostic Study Level II

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B. D. Haughom, MD (✉) · M. D. Hellman, MD ·
B. R. Levine, MD, MS
Rush University, Department of Orthopaedic Surgery,
1611 W. Harrison Blvd, Suite 200,
Chicago, IL 60612, USA
e-mail: bryan.haughom@gmail.com

W. W. Schairer, MD · B. U. Nwachukwu, MD
Hospital for Special Surgery,
Department of Orthopaedic Surgery,
535 East 70th St,
New York, NY 10021, USA

Introduction

In the setting of isolated unicompartmental knee osteoarthritis, many surgeons elect to perform UKA citing its potential benefits, including decreased operative time, smaller incision, less aggressive bony resection, preservation of cruciate ligaments, improved range of motion, shorter hospital length of stay, decreased morbidity and mortality, and its preserved knee kinematics [2, 15, 22, 23, 26, 36]. Despite these benefits, there appears to be conflicting reports in the literature with regards to the long-term survival of UKA implants; with registry data demonstrating increased rates of revision compared to TKA [20, 21, 28], while case series demonstrate equivalent outcomes [5, 10, 16, 17, 25, 27, 30, 32, 34]. Furthermore, controversy surrounds the impact of obesity on the long-term outcomes following UKA [8, 11].

Much of the literature surrounding UKA has focused on long-term survivorship, while few reports have evaluated its short-term complication rates after UKA [9]. In the current healthcare milieu, increasing pressures are placed on practitioners to identify highly successful procedures in order to maximize excellent outcomes, while minimizing complications. Furthermore, providers and payers alike should have a firm understanding of the rates of complications and the risk factors for complications for elective UKA.

Currently, there is a paucity of data on short-term complication rates and risk factors for complication that can be expected following UKA. We aimed to address this by analyzing the data currently available in the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database regarding UKA. The aims of our study were to (1) determine the short-term complication rates following primary UKA; (2) determine the independent risk factors for short-term complications following primary UKA; and (3) determine the independent risk factors for prolonged (>4 days) length of hospitalization following primary UKA.

Patients and Methods

We performed a respective analysis of the NSQIP database, using all available data (2005 through 2012), to identify all primary UKA performed during the predetermined time period. The NSQIP database is maintained by the American College of Surgeons and is not based upon insurance claims [1, 12]. The data is prospectively collected from the medical chart by a Surgical Clinical Reviewer and contains information regarding patient demographics, preoperative medical comorbidities, preoperative laboratory values, surgical details, in-hospital and post-discharge complications, as well as readmissions and reoperations [13, 18]. As of 2012, data is gathered from over 400 participating hospitals, including private, public, and academic hospitals.

All primary UKAs performed between 2005 and 2012 were identified using Current Procedural Terminology Codes (CPT code: 27446). We selected only patients with the primary procedure listed as UKA.

Patient information included demographics, as well as preoperative medical comorbidities, and laboratory values were reported for all patients (Table 1). Intraoperative characteristics including operative time, anesthesia type, and resident involvement were recorded as well (Table 2). Postoperative variables including length of stay as well as 30-day complication rates and mortality were calculated (Table 2). Complications were categorized based upon the previous reports [4]. Major systemic complications included pulmonary embolism (PE), acute renal failure, cardiac arrest or myocardial infarction, sepsis or septic shock, stroke, unplanned intubation, coma over 72 h, or death. Minor systemic complications included pneumonia, deep vein thrombosis (DVT), renal insufficiency, urinary tract infection (UTI), or prolonged ventilation (over 48 h). Major local complications included deep infection, reoperation for any reason, and peripheral neurological deficit. Minor local complications included superficial wound infection and wound dehiscence. Furthermore, overall complications included any of the major or minor systemic or local complications, as well as unplanned hospital readmission within 30 days.

The effect of individual risk factors on postoperative complications was determined using a univariate logistic regression and chi-squared analyses. Patient variables included in the analysis were age, gender, race, ASA grade, inpatient status, preoperative laboratory values, prolonged operative time (over 120 min), and transfusion. All variables with a p value of less than 0.1 were included in the multivariate regression model evaluating for all complications as well as prolonged length of stay (greater than 4 days). Odds rations (ORs) and 95% confidence intervals (CIs) are reported for the multivariate regression. Statistical significance was set at a p value less than 0.05. All analyses were performed using STATA (version 12.1 Statacorp, College Station, TX).

Table 1 Demographics, medical comorbidities, and preoperative laboratory values

Demographics		
Number	2316	
Age (years)	63.8±10.7	
Female	54.4%	(n=1259)
ASA	2.3±0.6	
BMI	31.4±6.3	
Race–White	77.0%	(n=1784)
Race–Black	5.4%	(n=126)
Race–Asian	1.1%	(n=26)
Race–Other	16.4%	(n=380)
Inpatient	86.7%	(n=2007)
Medical Comorbidities		
History of COPD	2.7%	(n=63)
History of CHF	0.0%	(n=1)
History of MI	0.0%	(n=1)
History of angina	0.3%	(n=6)
History of renal failure	0.0%	(n=0)
History of percutaneous cardiac intervention	4.0%	(n=93)
History of alcohol use	2.5%	(n=58)
History of cardiac surgery	3.2%	(n=73)
History of peripheral vascular disease	0.2%	(n=5)
History of dialysis	0.1%	(n=2)
History of TIA	1.8%	(n=42)
History of CVA with deficits	0.6%	(n=14)
History of CVA no deficits	0.7%	(n=16)
History of paraplegia	0.1%	(n=3)
History of hemiplegia	0.1%	(n=2)
History of quadraplegia	0.0%	(n=0)
History of chemotherapy	0.1%	(n=2)
History of metastatic cancer	0.0%	(n=1)
History of steroid use	1.4%	(n=32)
History of weight loss (>10%)	0.0%	(n=1)
History of bleeding disorder	1.9%	(n=45)
History of recent operation	0.3%	(n=6)
History of hypertension	57.3%	(n=1327)
History of smoking	10.2%	(n=236)
History of DM–Non insulin	11.3%	(n=261)
History of DM–Insulin	3.6%	(n=84)
Functionally independent	98.1%	(n=2271)
Preoperative Laboratory Values		
Creatinine	0.94±0.47	
Albumin	4.19±0.44	
White blood cell count	6.93±1.89	
Hematocrit	41.08±3.87	
Platelet count	243.2±68.2	
INR	1.03±0.21	
BUN	17.58±6.92	

Results

A total of 2316 UKAs, performed between 2005 and 2012, were included in our analysis (Table 1). The average age of

Table 2 Perioperative outcomes and complications following UKA

Operative time (min)	89.35±37.1	
Length of stay	2.23±2.0	
Transfusion	1.2%	(*n*=30)
Anesthesia–General	50.9%	(*n*=1225)
Anesthesia–Spinal	39.0%	(*n*=940)
Anesthesia–Epidural	1.1%	(*n*=26)
Anesthesia–Regional	6.5%	(*n*=157)
Anesthesia–Other	2.5%	(*n*=60)
Overall complication	3.2%	(*n*=76)
Death	0.0%	(*n*=0)
Unplanned readmission	2.1%	(*n*=28)
Complication–Major systemic	0.5%	(*n*=11)
Pulmonary embolism	0.1%	(*n*=2)
Acute renal failure	0.0%	(*n*=0)
Cardiac arrest	0.0%	(*n*=0)
Myocardial infarction	0.0%	(*n*=1)
Sepsis	0.2%	(*n*=5)
Septic shock	0.0%	(*n*=0)
CVA	0.1%	(*n*=2)
Unplanned intubation	0.1%	(*n*=2)
Coma	0.0%	(*n*=0)
Complications–Minor systemic	1.4%	(*n*=34)
Pneumonia	0.1%	(*n*=3)
DVT	0.5%	(*n*=11)
Renal insufficiency	0.0%	(*n*=1)
UTI	0.8%	(*n*=19)
Prolonged ventilation >48 h	0.0%	(*n*=1)
Complications–Major local	0.7%	(*n*=16)
Deep infection	0.3%	(*n*=7)
Peripheral neurological deficit	0.0%	(*n*=0)
Reoperation	0.9%	(*n*=12)
Complications–Minor local	0.9%	(*n*=22)
Superficial infection	0.7%	(*n*=18)
Wound dehiscence	0.2%	(*n*=4)

the cohort was 63.8±10.7 years at the time of the operation, with the majority of the patients being female (54.4%). The vast majority of our patients were Caucasian (77.0%), and the average BMI of our cohort was obese (31.4±6.3 kg/m^2). Of the procedures analyzed, 86.7% were performed on an inpatient basis. Preoperative medical comorbidities included hypertension (57.3%), non-insulin dependent diabetes (11.3%), smoking (10.2%), a history of percutaneous cardiac intervention (4.0%), a history of cardiac surgery (3.2%), insulin dependent diabetes (3.6%), and history of alcohol use (2.5%).

Overall, the reported risk of complications following UKA is low (Table 2). Operative time averaged 89.35± 37.1 min and length of stay was an average of 2.23 days. Resident surgeons were present in 36.8% of cases. The majority of cases were performed under general (50.9%) or spinal (39.0%) anesthesia. Postoperative transfusions were given in 1.2% of cases. There were no deaths. The reoperation rate was 0.9% while the unplanned readmission rate was 2.1%. The overall complication rate was 3.2%, with major systemic complications occurring in 0.5%, minor systemic in 1.4%, major local in 0.7%, and minor local complications occurring 0.9% of cases.

Table 3 Risk for overall complication following UKA

	Odds ratio	95% CI	Adjusted *p* value
BMI (per 5 points)	1.24	[1.03–1.51]	0.027*
ASA≥3	1.19	[0.61–2.32]	0.607
History of COPD	3.77	[1.33–10.72]	0.013*
History of DM	0.94	[0.41–2.16]	0.889
Resident present in case	0.29	[0.10–0.82]	0.020*
Preoperative BUN	1.02	[0.99–1.06]	0.188
Preoperative WBC	1.05	[0.92–1.19]	0.462

Following multivariate regression, independent risk factors for overall complications included increasing BMI (OR=1.24 for each increase of 5 points in BMI; p=0.027) and a history of COPD (OR=3.77; p=0.013). In addition, the presence of a resident in the case was a protective factor for complications (OR=0.29; p=0.020) (Table 3).

Following multivariate regression, independent risk factors for increased length of stay (LOS>4 days) included increasing BMI (OR=1.26 per increase in BMI of 5 points; p=0.001), ASA class of 3 or greater (OR=1.96; p=0.027), history of COPD (OR=3.64; p=0.010), a history of recent operation (within 30=days; OR=8.91; p=0.020), and postoperative transfusion (OR=3.96; p=0.030) (Table 4).

Discussion

Long-term clinical studies have demonstrated the efficacy and the durability of TKA [3, 14, 19, 24, 35]. However, in the setting of unicompartmental knee arthritis, UKA continues to be a popular choice in the carefully selected patient, with epidemiologic studies showing a growing demand [7, 33]. While UKA has been portrayed as the less invasive

Table 4 Risk for prolonged length of stay (>4 days)

	Odds ratio	95% CI	Adjusted *p* value
BMI (per 5 points)	1.26	[1.05–1.51]	<0.001*
Female	1.25	[0.68–2.28]	0.473
Age	1.20	[0.87–1.64]	0.268
ASA≥3	1.96	[1.08–3.57]	0.027*
History of COPD	3.64	[1.37–9.66]	0.010*
History of bleeding disorder	1.64	[0.42–6.46]	0.478
Recent operation	8.91	[1.42–55.98]	0.020*
History of DM	1.14	[0.57–2.28]	0.715
Inpatient procedure	6.66	[0.90–49.47]	0.064
Resident present in case	0.70	[0.36–1.35]	0.288
Preoperative HCT	1.03	[0.95–1.11]	0.494
General anesthesia (versus spinal)	2.66	[0.79–8.97]	0.114
Operative time ≥120 min	1.66	[0.83–3.31]	0.148
Transfusion	3.96	[1.15–13.68]	0.030*

arthroplasty choice for unicompartmental knee arthritis, little literature has examined postoperative morbidity, mortality, and risk factors for complications of this procedure [9, 29]. In an attempt to aid in patient selection as well quality improvement, we sought to (1) determine the short-term complication rates following primary UKA, (2) determine the independent risk factors for short-term complications following primary UKA, and (3) determine the independent risk factors for prolonged (>4 days) length of hospitalization following primary UKA.

Our study has several limitations. The principle limitation of our study is the lack of orthopaedic specific postoperative outcomes. However, it should be underscored that our analysis was not aimed at evaluating the orthopaedic outcomes following UKA, rather we were interested in looking at the postoperative morbidity and mortality surrounding the operation itself. Additionally, as a nationwide sample, the surgeons performing the operation are most assuredly heterogeneous in their technique. For example, we cannot control for the use of a tourniquet, antifibrinolytics, postoperative pain and physical therapy protocols, etc. While this is a limitation, it also serves as a strength, allowing our results to be more generalizable to surgeons at large. Finally, our multivariable analyses are based on database variables that may not accurately describe patient factors that may affect our outcomes. These unmeasured covariates would include factors such as case difficulty and a more descriptive preoperative physical status than “ambulatory” or “non-ambulatory”.

A review of the literature revealed a paucity of studies evaluating short-term complications following UKA. However, importantly, our patient demographics as well as operative characteristics were similar to prior series, making comparisons more accurate [7, 9, 21, 31]. Both Brown et al. in a multicenter retrospective analysis (n=605 UKAs) and Bolognesi et al. who published a Medicare registry analysis (n=3098 UKAs) evaluated postoperative morbidity and mortality following UKA as compared to TKA. While the Medicare analysis was focused on revision rates, they also evaluated the 90-day, 180-day, and 1-year rates of deep infection, thromboembolic events (DVT and PE), myocardial infarction, and all cause mortality [7]. Despite our shorter evaluation period, we demonstrated similar rates of thromboembolic phenomenon; however, we observed fewer deep infections and myocardial infarctions. Furthermore, similar to Brown et al., who evaluated 90-day morbidity and mortality of UKA, we demonstrated similar rates of readmission, reoperation, and thromboembolic disease [9]. Our postoperative transfusion rate was higher in comparison to their findings however.

To specifically evaluate for independent risk factors for complication following primary UKA, we performed a multivariate regression analysis. Our findings demonstrated two risk factors for complications, namely increasing BMI as well as COPD. Out data demonstrated a 24% increased risk of complication or hospital readmission with each increase of 5 in BMI. While the impact of BMI on the outcome of UKA has been debated in the literature with divergent results [8, 11], much of it has been centered on long-term outcomes. To the author’s knowledge, only one current study has evaluated the impact of obesity on short-term morbidity and mortality, also noting a deleterious effect [9]. While the jury remains inconclusive regarding the impact of obesity on the long-term survival of UKA implants, our data demonstrates the negative impact of obesity on short-term complications following UKA. Knowledge of the risk factors associated with postoperative complications is powerful information for providers. Surgeons should seek to optimize medical health and encourage weight loss prior to surgery. With regards to COPD, our data demonstrated a significant increase (OR=3.77) in complications. No prior reports have specifically evaluated the impact of COPD on outcomes following UKA; however, increased Charlson Comorbidity Scores have been shown to increase complications [9]. Resident involvement as a protective factor was an unexpected finding; however, our assumption is that resident involvement is a marker of a large volume center, which may contribute to improved outcomes [6].

Additionally, following multivariate analysis, we were able to determine the independent risk factors for prolonged length of stay following UKA. Our model demonstrated increasing BMI, increased ASA grade, a history of COPD, recent operation, and postoperative transfusion as risk factors. The finding of recent operation increasing the length of stay may be spurious given the widened confidence interval, and the low number of patients with this factor. To our knowledge, only one prior study has evaluated the risk factors on length of stay following UKA [9]. Brown et al. demonstrated increasing age, BMI, and Charlson Comorbidity index, as well as female gender as having an effect on length of stay. These results are in line with our findings, as we too found BMI to have an effect on length of stay. Additionally, comparisons can be drawn between ASA class and a history of COPD with the Charlson index, as they both speak to the overall health of the patient. The findings of transfusion increasing length of stay are novel, however transfusion has been shown to increase the risk of postoperative complications in prior reports, and thus is likely consistent with those findings.

Utilizing the NSQIP database, our data represent the second largest analysis of UKA in the literature. Our results demonstrated increasing BMI as well as a history of COPD to be independent risk factors for complications following UKA. A separate regression model determined that increasing BMI, as well as an ASA grade of three or greater, a history of COPD, recent operation, and postoperative transfusion were all risk factors for prolonged length of hospital stay. In the current healthcare environment, there is an onus placed on the surgeon and hospital to provide high quality outcomes with minimal complications, especially in the presence of elective surgery. These data provide practitioners as well as patients with potentially modifiable risk factors to avoid short-term complications as well as prolonged length of stay.

Disclosures

Conflict of Interest: Bryan D. Haughom, MD, William W. Schairer, MD, Michael D. Hellman, MD, Benedict U. Nwachukwu, MD and Brett R. Levine, MD, MS have declared that they have no conflict of interest.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was waived from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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