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A cost comparison of unicompartmental and total knee arthroplasty☆,☆☆

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ABSTRACT

Background: Unicompartmental knee arthroplasty (UKA) is an alternative to total knee arthroplasty (TKA) in appropriately selected patients. There is a paucity of data comparing hospital resource utilization and costs for UKA versus TKA.
Methods: We retrospectively reviewed 128 patients who underwent UKA or TKA for osteoarthritis by a single surgeon in the 2011 Fiscal Year. Sixty-four patients in each group were matched based on sex, age, race, body mass index, Charlson Comorbidity Index, and insurance type. Clinical data were obtained from medical records while costs were obtained from hospital billing. Bivariate analyses were used to compare outcomes.
Results: Both anesthesia and operative time (minutes) were significantly shorter for patients undergoing UKA (125.7 vs. 156.4; $p < 0.001$, and 81.4 vs. 112.2; $p < 0.001$). UKA patients required fewer transfusions (0% vs. 11.0%; $p = 0.007$) and had a shorter hospital stay (2.2 vs. 3.8 days; $p < 0.001$). 96% of UKAs were discharged home compared with 75% of TKAs ($p < 0.001$). Hospital direct costs were lower for UKA ($7893 vs. $11,156; $p < 0.001$) as were total costs (hospital direct costs plus overhead; $11,397 vs. $16,243; $p < 0.001$). Supply costs and implant costs were similarly lower for UKA ($701 vs. $781; $p < 0.001$, and $3448 vs. $5006; $p < 0.001$).
Conclusion: Our data suggest that UKA provides a cost-effective alternative to TKA in appropriately selected patients. As the number of patients with end-stage arthritis of the knee requiring surgical care continues to rise, the costs of caring for these patients must be considered.
Level of Evidence: Level III, case control study.

1. Introduction

Unicompartmental knee arthroplasty (UKA) is an alternative to total knee arthroplasty (TKA) in appropriately selected patients. The number of UKAs performed in the United States (US) is rising at triple the rate of TKAs [1], although both procedures are being performed with growing frequency [2–4]. Despite a projected large increase in the burden of knee arthritis [3,4] and much controversy regarding UKA [2], there is a surprising paucity of data comparing the costs of UKA and TKA.

A fair number of studies have compared clinical outcomes between UKA and TKA. Relative to TKA, UKA has been associated with shorter hospital stays, lower morbidity, more physiologic gait, and improved range of motion [5–8]. Improvements in surgical techniques, implant design, and adherence to defined surgical indications have yielded favorable clinical outcomes [9–11]. However, most registry studies still find a higher rate of revision for UKA versus TKA [12–16].

Few studies have compared financial costs associated with UKA versus TKA. This work is predominantly European registry-based [14–16] and has yielded conflicting findings. Swedish and English studies reported considerable cost savings with UKA stemming from reduced implant costs and hospital length of stay, even after accounting for the projected cost of future revisions [14,15]. Meanwhile, a Finnish study estimated that the initial cost savings of UKA did not cover the costs of extra revisions [16]. Applicability of these findings to the United States healthcare system is questionable because of the theoretical cost estimates and implant and surgeon variability associated with these registry-based studies. A final study by Soohoo et al. [17] used decision model analysis to show that UKA is a cost-effective alternative to TKA when durability and function are assumed to be similar. To our knowledge, however, no studies have presented a direct comparison of actual hospital billing figures for these two procedures. Thus, the purpose of this study was to compare hospital resource utilization and financial costs derived directly from hospital billing records for UKA versus TKA in a matched US patient population.

☆ All work was performed at Rush University Medical Center.
☆☆ Each author confirms that his institution approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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2. Materials and methods

After obtaining Institutional Review Board approval, we retrospectively reviewed 128 patients who underwent primary TKA (n = 64) or medial UKA (n = 64) for osteoarthritis by a single, fellowship-trained surgeon (CDV) between July 1, 2010 and June 30, 2011 (Fiscal Year 2011). The surgeon performed 224 primary TKAs and 69 UKAs over this time period. An a priori power analysis determined that 64 patients would be required in each group to identify a medium effect size ($f^2 = .30$) difference in cost given an alpha of 0.05 and a beta of 0.20. Patients were matched based on sex, age (within five years), race, body mass index (BMI) (18.5 to 29.9 vs. ≥30 mg/kg^2), Charlson Comorbidity Index [18] (<2 vs. ≥2), and insurance type. Paired patients were required to match on at least four of the six attributes, with 53 of 64 (82.8%) pairs matching on all six criteria (Table 1).

Criteria for the performance of medial UKA included: a diagnosis of non-inflammatory arthritis, localized medial symptoms without anterior knee pain, an intact anterior cruciate ligament, good range of motion (<10° flexion contracture, arc of motion >90°), minimal varus or valgus deformity (correctable on exam with <10° fixed varus or <5° fixed valgus), and focal medial tibiofemoral compartment arthritis with sparing of the lateral and patellofemoral compartments demonstrated on pre-operative weight-bearing radiographs and direct inspection intraoperatively. Contraindications to UKA included previous meniscectomy in the lateral compartment. We did not obtain stress radiographs or perform knee arthroscopy to evaluate the articular surface before proceeding with UKA surgery.

The Zimmer NexGen CR-Flex (Warsaw, IN, USA) prosthesis was utilized for all TKA procedures while the Zimmer Unicompartmental High-flex Knee System (Warsaw, IN, USA) was used for all UKA procedures; these are both fixed-bearing designs. The patella was resurfaced for all TKA procedures using a standard all-polyethylene button. A thigh tourniquet and a medial parapatellar approach were used in all cases and all implants were cemented. All patients received warfarin for postoperative thromboembolic prophylaxis and a neuraxial anesthetic was used uniformly. Perioperative protocols were identical between the UKA and TKA groups, including pre- and postoperative imaging and rehabilitation regimens.

Costs associated with the index hospitalization were obtained from hospital billing records while clinical data were obtained from medical records. All costs were measured in $US 2011 dollars. A 90-day postoperative period was used to detect clinical outcomes because this was the timeframe insurance payers used for global fees. Clinical outcomes recorded included operating time, anesthesia time, transfusions, hospital length of stay, discharge destination, and related hospital readmission within 90 days of surgery. Financial outcomes measured were implant costs (surgical implant plus cement costs), supply costs (including product categories such as medical gauze, elastic bandages, surgical masks, surgical tape, elastic tape, shoe covers and general wound care supplies), hospital direct cost (including blood, imaging, implants, lab, pharmacy, physical and occupational therapy, room and board, and surgical services), and total costs (hospital direct cost plus hospital overhead).

Table 1
Match characteristics for UKA vs. TKA cohorts.

Patient attribute	UKA n = 64 n (%) or M ± SD	TKA n = 64 n (%) or M ± SD	*p*-Value
Sex			
Male	26 (41%)	25 (39%)	0.857
Female	38 (59%)	39 (61%)	
Race			
White	49 (76%)	52 (81%)	0.343
Black or African American	9 (14%)	10 (16%)	
Other	6 (10%)	2 (3%)	
Age (years)	63.9 ± 8.6	63.9 ± 8.6	0.984
BMI			
18.5–29.9	38 (59%)	30 (47%)	0.311
≥30	26 (41%)	34 (53%)	
Charlson Index			
0–1	46 (42%)	46 (72%)	0.888
≥2	18 (28%)	18 (28%)	
Insurance type			
Commercial	32 (50%)	31 (48%)	0.659
Medicaid/charity care	4 (6%)	2 (3%)	
Medicare	28 (44%)	31 (48%)	

UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; % = percent; M = mean; SD = standard deviation; BMI = body mass index.

Table 2
Hospital resource utilization and clinical outcomes for UKA vs. TKA.

Outcome	UKA n = 64 n (%) or M ± SD	TKA n = 64 n (%) or M ± SD	*p*-Value
Operating room time (minutes)			
Surgical time	81.4 ± 25.5	112.2 ± 52.1	<0.001
Anesthesia time	125.7 ± 33.2	156.4 ± 53.0	<0.001
Occurrence of blood transfusion	0 (0%)	7 (11%)	0.007
Discharge destination			
Home or self care/home with home health	62 (96%)	48 (75%)	<0.001
Inpatient rehab/skilled nursing facility	2 (4%)	16 (25%)	
Hospital length of stay (days)	2.2 ± 1.1	3.8 ± 2.4	<0.001
Related readmission within 90 days	3 (5%)	6 (9%)	0.300

UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; % = percent; M = mean; SD = standard deviation; Rehab = rehabilitation.

2.1. Statistical analysis

Continuous variables were described using means and standard deviations and categorical variables were described using percentages and frequencies. Bivariate analyses were performed on the data to determine if there were statistically significant differences by surgery type in clinical outcomes and financial costs. Categorical variables were compared using the chi-squared test, while continuous variables were compared using an independent t-test (if normally distributed) or a Mann–Whitney test (if not normally distributed). Power analysis was performed using G*Power (Düsseldorf, Germany). All other statistical analyses were performed using SPSS version 16.0 Graduate Package (Chicago, IL, USA).

3. Results

UKA compared favorably to TKA for short-term clinical outcomes and measures of hospital resource utilization (Table 2). Both anesthesia and operative times (minutes) were significantly shorter for patients undergoing UKA. UKA patients required significantly fewer transfusions, had a shorter hospital stay and were discharged home more frequently. Related readmission rate within 90 days was lower for the UKA group but this difference failed to reach statistical significance with the numbers available for study (five percent vs. nine percent; $p = 0.300$). The three readmissions after UKA included two for superficial cellulitis managed with intravenous antibiotics and one for stiffness treated with manipulation under anesthesia. The six readmissions after TKA included three for acute deep infection treated with irrigation and debridement,

Table 3
Financial outcomes for UKA vs. TKA.

Cost	UKA n = 64 Mean ± SD	TKA n = 64 Mean ± SD	*p*-Value
Implant costs	$3448 ± $946	$5006 ± $2276	<0.001
Supply costs	$701 ± $195	$781 ± $338	0.001
Direct costs	$7893 ± $1863	$11,156 ± $3696	<0.001
Total costs	$11,397 ± $2741	$16,243 ± $5514	<0.001

UKA = unicompartmental knee arthroplasty; TKA = total knee arthroplasty; SD = standard deviation.

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