Retrospective Clinical Research Report

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
50(8) 1–10

DOI: 10.1177/03000605221115383
journals.sagepub.com/home/imr
SAGE

Outcome of mobile and fixed unicompartmental knee arthroplasty and risk factors for revision

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Abstract

Objectives: In this study, we aimed to evaluate the outcomes of patients undergoing unilateral knee arthroplasty (UKA) and to analyze risk factors that may lead to revision in patients who undergo UKA.

Methods: We included patients who underwent mobile or fixed UKA owing to osteoarthritis and who had at least 24 months of follow-up in the postoperative period. We recorded information on patient age, sex, side, body mass (kg/m^2), follow-up duration, Knee Society Score, Western Ontario and McMaster Universities Arthritis Index (WOMAC) pain, WOMAC function, WOMAC stiffness, mechanical axle angle, femoral component compliance, tibial component compliance, accumulated experience of the surgeon, and revision status.

Results: In total, we evaluated 131 knees in 118 patients. 50 (38%) who underwent mobile UKA and 81 (62%) who underwent fixed UKA. The effect of obesity on mobile and fixed UKA revision was significant. The likelihood of revision decreased with greater experience of the surgeon performing UKA.

Conclusion: Our study showed that the clinical results of mobile and fixed UKA procedures are similar. We also revealed that obesity poses a risk for revision in both fixed and mobile UKA, and the revision rate decreases with increased experience of the surgeon.

Keywords

Mobile unicompartmental arthroplasty, fixed unicompartmental arthroplasty, revision, knee, orthopedic surgery, obesity

Date received: 27 October 2021; accepted: 4 July 2022

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Introduction

As soft tissue-sparing surgery, unicompartmental knee arthroplasty (UKA) is a more prevalent treatment for anteromedial osteoarthritis (OA) than in the past. Specifically, UKA protects the suprapatellar extensor mechanism, meaning there is no need to shift the patella laterally, and UKA accelerates rehabilitation owing to a shorter operation time and hospital stay.[1] Other advantages are the patient's heightened activity level during discharge and a walking gait that is close to natural.[2] Another factor that plays a role in the longevity of UKA is the clear identification of patients with contraindications.[3,4] UKA offers several potential advantages over total knee arthroplasty (TKA), including preservation of native bone stock, retention of cruciate ligaments, lower perioperative morbidity[5] and enhanced postoperative recovery.[5,6]

In the UKA procedure, a prosthetic joint is inserted, which functions similar to a natural knee joint. Whereas morbidity and mortality rates are low in UKA, the duration of the prosthetic is shorter and the revision rate higher than in TKA.[7] Many studies have compared the results of UKA and TKA.[8,9] Increasingly more authors have stated that it is more realistic to compare the revision rates between mobile and fixed UKA than perform comparisons with TKA.[10,11]

In the present study, we compared patients who underwent mobile and fixed UKA. We aimed to reveal the clinical and functional differences in patients with mobile and fixed UKA and to identify risk factors that may lead to revision in patients who undergo UKA.

Methods

This study was conducted as a retrospective trial at our clinic between January 2008 and December 2018. In total, we analyzed 118 patients who underwent UKA owing to isolated anteromedial OA. The study protocol was approved by the Uludag University Ethics Committee (Date/No:2021/357). Participants in this study provided written informed consent for publication and treatment during hospitalization.

The inclusion criteria were female and male patients who underwent mobile or fixed UKA owing to OA and who had at least 24 months of follow-up in the postoperative period. Once the indication for UKA was established, the implant was provided by Istinye University, Istanbul. Some patients who underwent UKA of only the medial compartment had a unilateral prosthesis whereas the remainder had a bilateral prosthesis. Patients whose medical information could not be obtained or who underwent TKA were excluded. Included patients were divided into those treated with fixed UKA and patients treated with mobile UKA.

Surgical technique

All operations were performed by the same surgeon. Spinal anesthesia was given; antibiotic prophylaxis was administered (cefuroxime axetil) before the incision was made and continued for 48 hours postoperatively. Tourniquet hemostasis was applied in all cases. Both fixed and mobile UKA procedures were conducted by first generating an adequate surgical field of view with a medial parapatellar incision (6–8 cm). Similar incisions were made in both UKA types until the implant placement. The difficulty in mobile UKA compared with fixed UKA is that the heights at the anterior and posterior corners of the insert make reduction difficult between the femoral and tibial components. In our study, we applied different component placement orders to make insertion easier in mobile UKA. Implants were as follows: the Corin Uniglide Unicompartmental Knee System (Corin Group, Tampa, FL, USA) was used in 48 patients, the Zimmer Unicompartmental High Flex Knee System (Zimmer Biomet, Warsaw, IN, USA) was used in 51 patients, and the Smith & Nephew Journey UNI Unicompartmental Knee System (Watford, Hertfordshire, UK) was used in 56 patients. Low-molecular-weight heparin was started before the operation for thromboembolism prophylaxis and was continued for 2 more weeks postoperatively. Removing the UKA implant and follow-up roentgenograms led to revision (Figures 1–3). Orthoroentgenography (standing axial radiography) of the operated lower extremity and anteroposterior and lateral knee X-rays were taken and evaluated. Exercises required to increase range of motion were started on the first postoperative day and patients were mobilized on the same day. In Figure 3, roentgenograms of a sample case with UKA are presented.

After the procedure, we recorded the patient age; sex; side; body mass index (kg/m2); follow-up duration; Knee Society Score (KSS); scores for the Western Ontario and McMaster Universities Arthritis Index (WOMAC) pain, WOMAC function, and WOMAC stiffness; mechanical axis angle (MAA); femoral component compliance (FCC); tibial component compliance (TCC); accumulated

Figure 1. Standard drawings used according to Oxford group radiological evaluation criteria. Fixed unilateral knee arthroplasty at 11 years postoperatively.

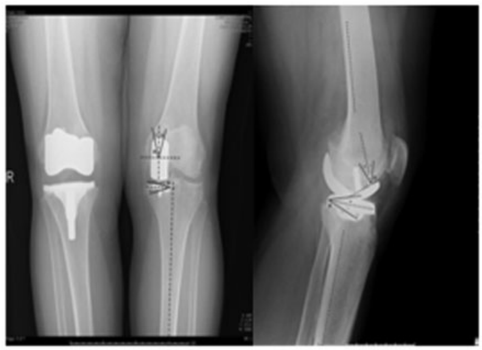

Figure 2. Standard drawings used according to Oxford group radiological evaluation criteria. Mobile UKA at 9 years postoperatively.

Figure 3. Example of mobile unilateral knee arthroplasty (UKA). a) A 48-year-old woman with medial joint osteoarthritis. b) Mobile UKA at 1 month postoperatively.

experience of the surgeon; and revision status. The same researcher performed all assessments to prevent any bias from affecting the measurements and scoring.

We investigated possible factors that affect mobile and fixed UKA revision according to three main categories, as follows. 1) The accumulated experience of the orthopedic surgeon with inserting knee prostheses and the total number of procedures performed, the number of UKA and TKA procedures performed (each), the ratio of TKA to UKA performed for the surgeon, the number of TKAs performed, and number of mobile and fixed UKA revisions. 2) Patient-dependent factors: age, sex, and obesity. 3) UKA conformity to the Oxford group radiological evaluation criteria (OGREC): mobile and fixed UKA FCC, TCC, and MAA values.[13]

For FCC, there should be a varus/valgus angle less than 10° and flexion/extension angle less than 5°. For TCC compliance, there should be a varus/valgus angle less than 10° and posterior slope between 7° and 5°. The MAA must be between 170° and 180° (Figures 1 and 2).

We followed the OGREC criteria when interpreting the results, as follows. FCC is evaluated as good or medium if the varus/valgus and flexion/extension angles are within acceptable limits. FCC is rated poor if the varus/valgus or flexion/extension angles are not within acceptable limits.

1. TCC is evaluated as good if the varus/valgus and posterior slope angles are within acceptable limits. TCC is rated medium if the varus/valgus or posterior tilt angles are within acceptable limits, and poor if the varus/valgus or posterior tilt angles are not within acceptable limits.
2. The MAA is evaluated as good if between 170° and 180°, medium with a deviation between 5° and 10°, and poor with a deviation of more than 10°.
3. A KSS below 60 points is considered poor, 60 to 69 is acceptable, 70 to 79 good, and 80 to 100 points is considered excellent.

Figure 1 shows standard drawings used according to OGREC, with fixed UKA at 131 months postoperatively. Figure 2 depicts standard drawings used according to OGREC, with mobile UKA at 106 months.

We assessed pain, stiffness, and physical function using the WOMAC. This scale is widely used in the evaluation of hip and knee osteoarthritis. The WOMAC is a self-administered questionnaire consisting of 24 items divided into three subscales (pain, stiffness, and physical function). The WOMAC measures five items for pain (score range 0–20), two for stiffness (score range 0–8), and 17 for functional limitations (score range 0–68)

We confirmed the classification and grade of obesity in accordance with World Health Organization guidelines.[14]

Statistical analysis

We used IBM SPSS version 18.0 (IBM Corp., Armonk, NY, USA) to evaluate the data. We used visual (histograms, probability plots) and analytical methods (Kolmogorov–Smirnov and Shapiro–Wilk tests) to determine the normal distribution of the data. Differences between groups were evaluated using the Student *t*-test for parametric data and the Mann–Whitney U-test for non-parametric data. Relationships between categorical variables were analyzed using the chi-squared test. We considered a p-value < 0.05 to be statistically significant.

Results

We initially included 155 knees in 137 patients who underwent a UKA procedure performed by the same orthopedist during the study period. In total, three patients died. Two patients underwent revision surgery owing to post-traumatic insertion and femoral component displacement. Another 13 patients were excluded from the study because they could not be followed up. In total, we finally evaluated 131 knees in 118 patients (19 knees in 18 men and 112 knees in 100 women). The mean patient age was 56 (range: 44–65) years; the mean age among women was 55 (range: 44–65) years and that among men was 57 (range: 48–65) years. Table 1 shows the age and sex distribution table of patients who underwent fixed and mobile UKA.

UKA procedures were performed on the left knee in 49 (37%) patients and on the right knee in 82 (63%) patients. Of these, 50 patients underwent mobile UKA and 81 underwent fixed UKA procedures. The shortest follow-up period was 2 years, and the longest follow-up was 13 years; the average follow-up was 9 years.

Table 2 presents the results of evaluation for parameters affecting the clinical evaluation of patients who underwent UKA and revision of UKA. There was no statistically significant difference between the groups who underwent fixed and mobile UKA according to age, sex, side, or average KSS. The mean follow-up time for mobile UKA was 8 (range: 3–11) years and 7 (range: 2–11) years for fixed UKA. The mean follow-up time for mobile UKA was significantly longer than that for fixed UKA ($p = 0.002$). The reason for this was that our first cases predominantly underwent mobile UKA.

The KSS was within acceptable limits in 9 knees (6.87%), good in 62 knees (47.32%), and excellent in 60 knees (45.8%). Whereas there was no difference between the functional averages of mobile and fixed UKA WOMAC scores, there was a significant difference in favor of mobile UKA in terms of pain ($p = 0.049$) and stiffness ($p = 0.014$).

Table 1. Age and sex distribution of fixed and mobile UKA

	Number of knees	Age, years	Minimum	Maximum
Fixed UKA				
Men	10	58 ± 4	52	65
Women	71	57 ± 6	44	65
Total	81	57 ± 5	44	65
Mobile UKA				
Men	9	55 ± 4	48	62
Women	41	55 ± 5	46	65
Total	50	55 ± 5	46	65

UKA, unilateral knee arthroplasty.

There was no significant difference between fixed and mobile UKA, FCC, or TCC. The total number of knee prosthesis procedures performed by the same surgeon (TKA and UKA) was 1149 (1018 TKA, 131 UKA), with a UKA to TKA ratio of 12.8%. In our study, we two patients in the mobile UKA group and three in the fixed UKA group received revision. The surgeon's UKA revision rate was 3.8%; the mobile UKA revision rate was 4%, the fixed UKA revision rate was 3.7%, and the TKA revision rate was 2.1% (21 of 56 TKA revisions were our own cases). There was no significant difference in the revision rate between UKA groups.

An effect of obesity on the rate of mobile and fixed UKA revision was observed in this study, although the difference between these groups was not statistically significant. However, obesity was significant in patients who underwent UKA ($p < 0.001$). Figure 4 shows insert dislocation and revision TKA in a patient who underwent UKA at 7 years postoperatively.

Per the suggestion of a consulted expert, when one knee that had been previously excluded from the study was included in the fixed UKA group, the total number of revisions was four (three plus one). When two knees that had been previously

Table 2. Evaluation of parameters affecting UKA revision

		Fixed UKA N = 81		Mobile UKA N = 50		
Age	Mean	57.0 ± 5.0		55.0 ± 5.0		0.084
Sex	Male	10 (12.3%)		9 (18.0%)		0.372
	Female	71 (87.6%)		41 (82.0%)		
	Right	52 (64.2%)		30 (60.0%)		
Side	Left	29 (35.8%)		20 (40.0%)		0.631
	Mean ± SD	9.0 ± 3.0		8.0 ± 2.0		
Follow–up time	Median (IQR)	7.0 (5.0–9.0)		9.0 (6.0–10.0)		**0.002**
KSS	Mean ± SD	78.5 ± 6.6		79.4 ± 7.2		0.497
	Mean ± SD	2.7 ± 1.3		2.3 ± 1.2		
WOMAC pain	Median (IQR)	2.0 (2.0–3.5)		2.0 (2.0–2.2)		**0.049**
	Mean ± SD	6.0 ± 4.2		5.0 ± 2.1		
WOMAC function	Median (IQR)	5.0 (4.0–6.0)		5.0 (4.0–5.0)		0.591
	Mean ± SD	2.0 ± 1.4		1.4 ± 1.0		
WOMAC stiffness	Median (IQR)	2.0 (1.0–3.0)		1.0 (1.0–2.0)		**0.014**
	Medium	8.0	9.8%	4.0	8%	
MAA	Good	73	90.1%	46	92.0%	0.718
	Bad	3	3.7%	0	0.0%	
	Medium	44	54.3%	20	40.0%	
FCC	Good	34	41.9%	30	60.0%	0.074
	Medium	5	6.1%	1	2.0%	
TCC	Good	76	93.8%	49	98.0%	0.406
	None	78	96.3%	48	96.0%	
Revision	Yes	3	3.7%	2	4.0%	0.931
	Normal	26	32.1%	24	48.0%	
	Grade 1	33	40.7%	13	26.0%	
	Grade 2	3	3.7%	2	4.0%	
Obesity	Overweight	19	23.4%	11	22.0%	0.262
	Normal	26	32.1%	24	48.0%	
	Grade 1–2	36	44.4%	15	30.0%	

Values in the table are n, %, or n (%), unless otherwise noted.
SD, standard deviation; IQR, interquartile range; KSS, Knee Society Score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Arthritis Index; MAA, mechanical axle angle; FCC, femoral component compliance; TCC, tibial component compliance.

excluded were included in the mobile UKA group, the total revisions was four (two plus two). We conducted evaluation using the updated revision numbers. We found no significant difference between the mean WOMAC score of both groups. There was no significant difference in the average WOMAC function scores between groups. There was a significant difference in favor of mobile UKA in terms of WOMAC pain score ($p = 0.009$) and stiffness score ($p = 0.042$). There was no significant difference between the groups in terms of FCC and TCC. There was no significant difference in the distributions according to the presence of revision between the fixed UKA and mobile UKA groups (data not shown).

Discussion

Our results regarding OGREC, KSS, and WOMAC showed acceptable success rates for mobile and fixed UKA procedures. Still,

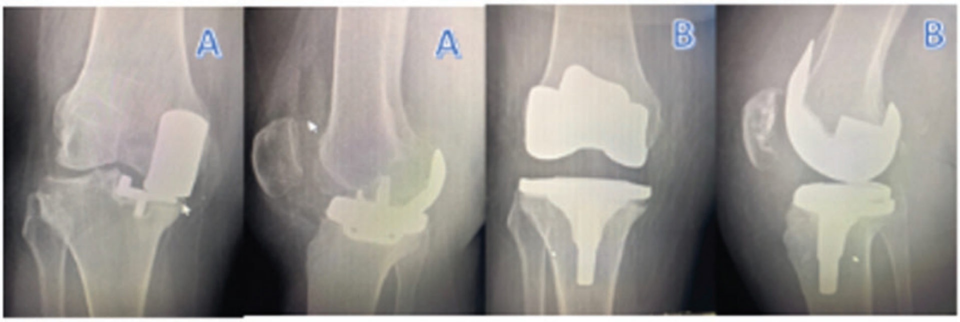

Figure 4. Example of complications. a) Insert dislocation in the suprapatellar region at 7 years postoperatively. White arrow: position of dislocation. b) Revision with total knee arthroplasty.

there was a significant difference in favor of mobile UKA in terms of WOMAC scores (pain and joint stiffness) in comparison with fixed UKA. We believe that the difference between groups for KSS and WOMAC scores is because mobile UKA more frequently meets patient expectations. There was no significant difference between the WOMAC function results, OGREC, or revision rates. Whereas obesity increased the rate of UKA revision, greater accumulated experience with knee replacement on the part of the surgeon decreased the revision rate.

Studies have reported successful long-term results in UKA and have stressed the importance of correct patient selection, the surgeon's accumulated experience with the prostheses, and the appropriate choice of UKA (mobile or fixed).[15–17] Appropriately performed UKA has demonstrated successful and effective clinical results.[18] In a group of patients under 60 years of age who underwent UKA, 93% returned to normal activities and demonstrated rapid improvement in physical activity.[19] The main reason for partial activity limitation is the patients' perceived need to take precautions.[19]

Whereas faster recovery, lower complication rates, and better functional results are more common after UKA than TKA, the revision rate is three times higher in UKA.[20] Acute mechanical symptoms owing to excess retained cement in the posterior compartment of the knee joint following UKA are uncommon.[21] Comparing revision rates between UKA and TKA is also controversial, with many reports stating that such comparison is incorrect.[22] Although there may be radiological compliance in UKA, revision is based on the pain complaints of individual patients. Greater satisfaction with TKA revision also increases the revision rate.[2]

One way to reduce the UKA revision rate is to improve surgeons' experience by performing UKA in 20% of all TKAs (14). The TKA to UKA ratio of the surgeon in our cases was 12.8%, and this surgeon's annual rate of UKAs performed was 11.9% of all procedures. Correlation between the surgeon's experience with knee prosthetics and the number of years performing UKA has been reported; with 12 to 30 UKAs performed annually, the revision rate is 1.5%, and this is 1% with 30 or more UKAs.[8] Our revision rate decreased as the number of UKA procedures increased, making our study findings comparable with previous findings. In the first 5 years after we began performing UKA, we conducted revisions in four patients, compared with one patient in the following 5 years. The weak point in this comparison is that the follow-up period of patients who underwent UKA was longer during the first 5 years than in the following 5 years.

The MAA should be between 170° and 180°. The presence of varus MAA leads to increased insert thickness and polyethylene wear, and the presence of valgus MAA causes rapid progression of OA in the lateral joint, with early revision occurring in both angular problems.[23] In our study, we balanced the MAA according to the transition position from 8 mm medial to the midpoint of the knee (if the cable passes through the midpoint of the knee, the MAA is in varus, and if the cable passes through the lateral knee, it is in valgus). We used a fluoroscopic view or stretched the cautery cable through the midpoint of the femoral head and ankle. We measured an MAA with a deviation of more than 5° in 12 cases but at the appropriate angle in all others.

We found no significant difference between the revision rates among different UKA designs (mobile, and fixed). Whereas studies have reported different reasons for revision between mobile and fixed UKA, no significant difference has been reported between revision rates, and no difference observed in clinical results.[10,24] In a meta-analysis investigating the reasons for UKA revision, the primary reasons were polyethylene abrasion (12%) and instability (12%) in fixed UKA and pain (14%) and insert dislocation (11%) in mobile UKA.[25] In a study comparing 375 indexes, OA in the lateral joint and aseptic loosening of the UKA component were the most common causes of revision in mobile UKA; however, arthrofibrosis and medial tibia plateau fracture were most common in fixed UKA revision.[11]

Per the advice of an expert, we included previously excluded patients in a second analysis, and the absence of statistically significant findings supported our exclusion criteria. We found no significant difference in the revision rates or WOMAC function scores between fixed and mobile UKA in obese patients; however, other studies have indicated that fixed UKA is preferable for obese patients primarily owing to the risk of insert dislocation.

Some limitations in our study should be mentioned. This was a retrospective study and there were very few patients with UKA revision included in this study.

Conclusion

Our study showed that the clinical results of mobile and fixed UKA procedures are similar. Successful results could be obtained in both groups at acceptable rates in the evaluation of OGREC and CSR results. Our study also revealed that obesity poses a risk for revision in both fixed and mobile UKA, and the revision rate decreases with more experience accumulated by the surgeon. However, larger multicenter studies using a prospective design are needed to definitively determine the relationship of UKA with factors related to revision.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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