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Clinical outcomes and patient satisfaction following revision of failed unicompartmental knee arthroplasty to total knee arthroplasty are as good as a primary total knee arthroplasty

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ABSTRACT

Background: With unicompartmental knee arthroplasty (UKA) being increasingly performed for medial compartment osteoarthritis (OA) of the knee, revision total knee arthroplasty (TKA) for failed UKA is expected to increase. Our primary aim is to evaluate patients in our tertiary institution who underwent revision of failed UKA to TKA to compare their pre-operative clinical scores (patient-reported outcome measures, PROMs) to those of primary TKA.
Methods: Retrospective review of our institutional arthroplasty registry between 2001 and 2014 was performed. We identified 70 patients who underwent revision of UKA to TKA. The revision UKA to TKA patients was matched with 140 patients who underwent primary TKA for OA in terms of preoperative demographics, gender, age at time of surgery, body mass index (BMI), primary surgeon, and PROMs. Intra-operative data and postoperative complications or re-revision surgeries performed were reviewed.
Results: In the revision UKA to TKA group, more stems, augments or constrained implants were used compared to primary TKA. A greater proportion of patients with metal-backed UKA revision to TKA required stems, augments or constrained implants as compared to all-polyethylene UKA revision to TKA, but not a significant proportion ($P = 0.250$). At two years postoperatively, there were no significant differences observed between the groups in terms of patient satisfaction and PROMs.
Conclusions: This study showed similar outcomes following revision of failed UKA to TKA and primary TKA. There were significant improvements in PROMs for revision UKA to TKA, which is comparable to that of primary TKA.

1. Introduction

Unicompartmental knee arthroplasty (UKA) is a surgical option for the management of medial compartmental osteoarthritis (OA) of the knee [1]. UKA has been shown to have good long-term survivorship, kinematics as well as patient-reported outcome measures (PROMs) by several studies [2–6]. However, as compared to total knee arthroplasty (TKA), registry results showed that UKA was revised more frequently and earlier [7,8]. However, the revision of UKA to TKA is generally a simpler procedure as compared to revision of TKA to TKA [9] and also has substantially better survivorship [1]. It has also been reported in some studies [9–12] that the revisions of UKA failures to TKA have similar outcomes when compared to primary TKA. Surgeons may prefer to

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use UKA for younger patients in order to postpone TKA, as there are reported results that revisions of UKA failure to TKA are equal to that of primary TKA, and may be better than revision of a failed TKA [9,11,13]. However, it has recently been proposed that UKA should not be considered as an alternative procedure to TKA, as failed UKA may have worse postoperative clinical outcomes based on Western Ontario and McMaster Universities Osteoarthritis Index and Oxford Knee Score (OKS) than the primary TKA group [14]. The main aim of this study was to evaluate patients in our institution who underwent revision of failed UKA to TKA to compare their PROMs, and the secondary aims of this study were to evaluate the implants/augments utilized and rate of complications compared to those of primary TKA. We hypothesize that the outcomes of failed UKA revised to TKA is similar to those of primary TKA.

2. Patients and methods

After institutional review board approval, we performed a retrospective review of our institutional arthroplasty registry between 2001 and 2014. We identified 70 patients (involving 70 knees) who underwent revision of UKA to TKA. Five patients were lost to follow-up and were not included in this study. The revision UKA to TKA patients was matched with 140 patients (involving 140 knees) who underwent primary TKA for osteoarthritis in terms of preoperative demographics, gender, age at time of surgery, body mass index (BMI), primary surgeon, and preoperative clinical scores (patient-reported outcome measures, PROMs). The two groups of patients had PROMs and demographics matched to ensure that the follow-up differences in PROMs were not influenced by the preoperative differences in PROMs or demographics. Preoperative data analyzed included demographics (Charlson age-comorbidity index [15], BMI, age and gender) and preoperative PROMs (Short Form (SF)-36 [16] both physical component scores (PCS) and mental component scores (MCS); OKS (overall score ranging from 12 to 60, with 12 being the best outcome) [17] and Knee Society Score (KSS) [18], split into objective and functional components).

The clinical details of all patients were reviewed up to December 2017 with a minimum follow-up of two years. The mean follow-up period was 7.9 years (two to 10.7 years) for primary TKAs and 6.1 years (two to 13.8 years) for revised UKAs.

All of the clinical notes for the patients were evaluated. The intraoperative data included whether primary TKA components were used or whether revision systems including stems, augments or constrained bearings were required during the operation. The PROMs were evaluated at six months and two years. We also evaluated any postoperative complications or re-revision surgeries performed for both the TKAs for failed UKA and primary TKA patients.

The patients in each cohort were well matched and similar in terms of gender, Charlson age-comorbidity index, age, BMI, flexion range of movement, KSS (Function and Knee) score, OKS and SF-36 MCS ($P > 0.05$) (Table 1). All of the UKAs were fixed-bearing tibial components with 31/70 (44%) being all-polyethylene and 39/70 (56%) being metal-backed. UKAs were being revised for progression of OA (31 cases), aseptic loosening and subsidence related to polyethylene wear (38 cases) and stress fracture (one case). The mean time from primary UKAs to revision TKA was 6.1 years (two to 13.8 years).

All of the revision UKAs and primary TKAs were all single-stage procedures performed in a tertiary arthroplasty centre by one of 10 fellowship-trained arthroplasty surgeons. Postoperatively, all patients underwent supervised physiotherapy and were managed according to a standardized postoperative clinical pathway, which included a supervised range of movement exercises, ambulatory physiotherapy with full weight bearing as tolerated and stair climbing.

Table 1
Patient demographics and preoperative clinical scores of the unicompartmental knee arthroplasty (UKA) to total knee arthroplasty (TKA) and primary TKA group.

Preoperative clinical details	UKA to TKR	Primary TKA	*P*
Number of patients	70	140	NA
Gender	Male patients = 12 (17.1%) Female patients = 58 (82.9%)	Male patients = 24 (17.1%) Female patients = 116 (82.9%)	1
Index surgery (years ago) (SD)	6.1 (3.3)	NA	NA
Reasons for TKA	Progression of osteoarthritis (n = 31) Aseptic loosening and subsidence secondary to polyethylene wear (n = 38) Stress fracture (n = 1)	Osteoarthritis (n = 140)	NA
Charlson age-comorbidity index at revision TKA (SD)	2.8 (1.2)	3.1 (1.3)	0.312
Age at time of surgery (years) (SD)	65.2 (7.8)	66.7 (6.6)	0.143
Body mass index (SD)	29.3 (5.4)	27. (4.1)	0.063
Flexion range of movement (degree) (SD)	115.6 (17.9)	115.3 (17.2)	0.911
KSS – Functional Score (SD)	53.6 (19.7)	50.2 (17.1)	0.191
KSS – Knee Score (SD)	36.2 (9.4)	35.5 (8.2)	0.440
Oxford Knee Score (SD)	36.4 (9.4)	35.5 (8.2)	0.476
SF-36 Physical component Score (PCS) (SD)	31.0 (10.0)	32.9 (10.5)	0.226
SF-36 Mental component Score (MCS) (SD)	51.1 (11.2)	50.6 (10.2)	0.742

n, number of patients; NA, not applicable; SD, standard deviation.
Significant at $P < 0.05$.

2.1. Statistical analysis

Descriptive statistics were performed with continuous variables being presented as means and standard deviations (SD). Normality of data was confirmed using the Shapiro–Wilk test. Power analysis was performed to ensure that the study sample size was adequate. A sample size of 70 cases and 140 controls was estimated based on a 1:2 matching and an odds ratio of 0.2. The sample size was based on achieving a 95% power with an alpha risk of five percent.

The means of two groups (revised UKAs and primary TKAs) were compared using independent samples *t*-test and paired *t*-tests were used to compare pre- and postoperative data within groups. Categorical data were compared using Z-scores. Means with multiple groups were compared using the Kruskal–Wallis test. Statistical significance was set at $P < 0.05$ and all analyses were performed with SPSS version 21 (IBM Inc., Armonk, NY, USA).

3. Results

In our study, all of the 140 primary TKAs performed were cemented implants, with short, fully cemented tibial keels, of which there were 108 posterior-stabilized (PS) TKA and 32 cruciate-retaining (CR) TKA. In the revision UKA to TKA group, stems, augments or constrained implants were used in 37 out of 70 UKA patients (52.8%, Table 2) and 3/140 (2.1%, Table 3) for the primary TKA group, which have a significant difference ($P < 0.001$) compared to the primary TKA group. For the revision UKA to TKA groups, 45 were CR and 25 were PS TKA; stemmed implants are more often used for the tibia (22/70; 31.4%), followed by for both femur and tibia (6/70; 8.6%). For the revision UKA group, four patients (5.7%) required constrained condylar knee implants, which was significant compared to primary TKA ($P = 0.004$). A greater proportion of patients (23 out of 39 patients (59%)) with metal-backed UKA revision to TKA required stems, augments or constrained implants as compared to all-polyethylene UKA revision to TKA (14 out of 31 patients (45.1%)), but not significant ($P = 0.250$). Similarly, a greater proportion of patients (17 out of 39 patients (43.6%)) with metal-backed tibia component UKA revision patients had PS TKA compared to all-polyethylene tibia component UKA revision patients (eight out of 31 patients (25.8%)), but this number was not significant ($P = 0.124$).

All patients undergoing primary TKA underwent standard medial parapatellar approach, whereas extensile surgical approach was necessary using quadriceps snip [19] for 6/70 (8.6%) of the revision UKA patients ($P < 0.001$). The rates of re-operations due to complications were more frequent in the primary TKA group (5/140) as compared to revision UKA group (1/70), but not significant ($P = 0.3796$). There was one case of superficial postoperative infection for both the revision UKA and primary TKA group, which was successfully treated with debridement and closure of wound. Manipulation under anesthetic was necessary for two patients in the primary TKA group, one for persistent postoperative stiffness and one for non-traumatic knee dislocation due to 'jump cam'. One patient in the failed UKA group underwent re-revision TKA at five years postoperatively due to aseptic loosening. Two patients required revision TKA on follow-up for the primary TKA group: one at two years postoperatively, due to prosthetic joint infection necessitating a two-staged revision TKA and one at one month postoperatively with constrained implants due to persistent instability.

At six months, primary TKA had significantly better KSS ($P = 0.004$) and OKS ($P = 0.022$) than revision UKA to TKA (Table 3). However, the differences were not within the minimally clinical important difference (MCID) for OKS [20] and KSS [21]. There were a greater proportion of patients who were satisfied and reported having their expectations of surgery met in the primary TKA group. However, at two years postoperatively, there were no significant differences between the groups in terms of

Table 2
Types of implants used, follow up duration and postoperative complications of the primary total knee arthroplasty (TKA) and revision unicompartmental knee arthroplasty (UKA) to TKA group.

Clinical details	Primary TKA	UKA to TKA	*P*
Types of TKA implants used			
No stems or augmentation required, n (%)	137 (97.9%)	33 (47.2%)	<0.001*
Tibial stem, n (%)	2 (1.4%)	22 (31.4%)	<0.001*
Femur and tibial stem, n (%)	0 (0%)	6 (8.6%)	<0.001*
Tibial stem and medial block augments, n (%)	1 (0.7%)	4 (5.7%)	0.025*
Femur, tibial stem and block augmentation, n (%)	0 (0%)	1 (1.4%)	0.156
Constrained condylar knee bearings, n (%)	0 (%)	4 (5.7%)	0.004*
Extensive surgical exposure with quadriceps snip required, n (%)	0	6 (8.6%)	<0.001*
Mean follow-up post-operatively after TKA (years) (SD)	7.9 ± 1.7 (Range: 2–10.7)	6.1 ± 3.3 (Range: 2–13.8)	<0.001*
Complications (number of patients)			
Wound infection treated with irrigation and debridement	1	1	0.617
Knee stiffness with manipulation under anesthesia	1	0	0.478
Knee dislocation due to jump cam with manipulation under anesthesia	1	0	0.478
Prosthetic joint infection	1	0	0.478
Revision TKA due to knee instability	1	0	0.478

n, number of patients; SD, standard deviation.
* Significant at P < 0.05.

Table 3
Six months follow up with comparison of clinical outcomes (means with standard deviation (SD)) between the revision unicompartmental knee arthroplasty (UKA) and primary total knee arthroplasty TKA group.

6 months follow-up	UKA to TKA	Primary TKA	P
Flexion range of movement (degree) (SD)	112.8 (12.1)	113.1 (15.3)	0.883
KSS – Functional Score (SD)	68.1 (16.4)	70.9 (16.6)	0.275
KSS – Knee Score (SD)	77.6 (16.0)	84.3 (10.7)	0.004*
Oxford Knee Score (SD)	21.7 (7.6)	19.2 (5.3)	0.022*
SF-36 Physical Component Score (PCS) (SD)	46.5 (8.5)	47.0 (10.9)	0.762
SF-36 Mental Component Score (MCS) (SD)	55.2 (10.7)	55.8 (10.3)	0.700
Percentage of patients whose expectations are met by surgery	74.5%	93.6%	<0.001*
Percentage of patients satisfied with overall results of surgery	80.9%	96.4%	<0.001*

KSS, Knee Society Scores; SF-36, Short Form-36.
* Significant at $P < 0.05$.

Table 4
Two-year follow-up with comparison of clinical outcomes (means with standard deviation (SD)) between the revision unicompartmental knee arthroplasty (UKA) to total knee arthroplasty (TKA) and primary TKA group.

2-year follow-up	UKA to TKA	Primary TKA	*P*
Flexion range of movement (degree) (SD)	117.1 (12.3)	114.6 (15.1)	0.337
KSS – Functional Score (SD)	71.6 (19.2)	75.9 (16.8)	0.163
KSS – Knee Score (SD)	81.1 (12.7)	86.7 (9.9)	0.110
Oxford Knee Score (SD)	19.3 (7.6)	17.6 (3.8)	0.190
SF-36 Physical component Score (PCS) (SD)	47.9 (10.8)	49.7 (8.4)	0.320
SF-36 Mental component Score (MCS) (SD)	54.9 (9.9)	56.0 (11.2)	0.563
Percentage of patients whose expectations are met by surgery	87.5%	92.5%	0.173
Percentage of patients who are satisfied with overall results of surgery	87.5%	92.5%	0.173

KSS, Knee Society Scores; SF-36, Short Form-36.

PROMs, both in terms of total score as well as change of score from preoperative score. A similar proportion of patients in each group were satisfied and reported having their expectations of surgery met (Tables 4, 5). We made comparisons within the UKA group (Table 6) for the implants utilized and the reasons for failure for the UKA prior to revision TKA. At two years, there was no difference between patients who used stemmed, augments or constrained implants versus non-stemmed implants. There was also no difference between patients who were revised for progression of disease or wear and loosening. Neither of these subgroups showed significantly different outcomes compared with those of primary TKA at two years follow up. At 6.1 (range: two to 13.8) years follow up, none of the revision UKA patients required re-revision for their TKA.

4. Discussion

In our study, the results demonstrate similar clinical outcomes and patient satisfaction following revision UKA to TKA and primary TKA at two-year follow-up. There were similar PROMs in the two groups, both in terms of absolute score and degree of change from preoperatively. We found no significant difference between revision UKA to TKA and primary TKA in terms of risk of re-operation due to complications. However, revision UKA to TKA more frequently required extensile surgical exposure with quadriceps snip, stemmed implants and constrained bearing implants as compared with primary TKA.

Table 5
Degree of change between pre-, 6 months and 2 years post-operative scores (means with standard deviation (SD)) between the unicompartmental knee arthroplasty (UKA) to total knee arthroplasty (TKA) and primary TKA group.

Difference between pre-operative vs. follow-up	UKA to TKA (6 months)	Primary TKA (6 months)	*P*	UKA to TKA (2 years)	Primary TKA (2 years)	*P*
Flexion range of movement (degree) (SD)	5.75 (2.5)	2.1 (1.7)	0.406	0.7 (1.7)	0.5 (1.4)	0.951
KSS – Functional Score (SD)	13.6 (20.5)	22.4 (18.1)	0.006*	21.2 (21.1)	25.9 (16.4)	0.226
KSS – Knee Score (SD)	40.9 (27.3)	51.7 (22.1)	0.035*	46.5 (23.9)	55.0 (20.7)	0.096
Oxford Knee Score (SD)	14.8 (11.1)	17.3 (7.7)	0.143	18.4 (8.9)	20.3 (8.9)	0.296
SF-36 Physical Component Score (PCS) (SD)	15.5 (13.4)	15.6 (13.1)	0.971	17.9 (12.9)	20.5 (11.5)	0.214
SF-36 Mental Component Score (MCS) (SD)	4.0 (10.8)	3.8 (11.1)	0.931	4.0 (12.8)	7.1 (13.1)	0.336

KSS, Knee Society Scores; SD, standard deviation; SF-36, Short Form-36.
* Significant at $P < 0.05$.

Table 6
Kruskal–Wallis test for patient-reported outcome scores in subgroup analysis within the unicompartmental knee arthroplasty (UKA) group at pre-, 6 months and 2 years postoperatively.

Patient-reported outcome measures	Implants utilized		Reason for revision	
	χ^2	P	χ^2	P
Preoperative KSS functional score	5.135	0.077	0.112	0.738
Preoperative KSS knee score	7.057	0.008*	0.145	0.704
Preoperative Oxford knee score	1.205	0.272	0.002	0.961
Preoperative SF-36 physical component score	1.216	0.270	0.005	0.942
Preoperative SF-36 mental component score	0.035	0.852	0.841	0.359
6 months KSS functional score	1.327	0.249	0.707	0.400
6 months KSS knee score	9.962	0.002*	1.453	0.228
6 months Oxford knee score	5.563	0.018*	0.678	0.410
6 months SF-36 physical component score	0.601	0.438	0.523	0.469
6 months SF-36 mental component score	0.331	0.565	1.269	0.260
2 years KSS functional score	0.393	0.531	1.736	0.188
2 years KSS knee score	0.585	0.444	0.948	0.330
2 years Oxford knee score	1.529	0.216	3.015	0.082
2 years SF-36 physical component score	0.345	0.557	1.045	0.440
2 years SF-36 mental component score	1.180	0.277	0.204	0.652

KSS, Knee Society Score; SF-36, Short Form-36.
* Significant at $P < 0.05$.

The main technical difficulty during revision UKA is the presence of substantial bone loss, which can arise from the bone cuts during primary UKA, osteolysis due to polyethylene wear as well as during UKA implant removal during the revision procedure, which needs to be addressed with bone grafting and/or use of revision implants [23–27]. The use of stemmed implants also aids the surgeon's need to protect damaged bone during revision UKA [1].

Many authors [25–30] have reported that the surgical procedure of revision UKA to TKA is less technically demanding than revision TKA to TKA. However, there are no significant differences in functional outcome, pain score, satisfaction and health-related quality of life between revision UKA to TKA and revision TKA to TKA [9,28]. Cross et al. [22] reported that revision UKA is technically less demanding than revision TKA to TKA in terms of shorter operating times and less use of stems, augments, and/or constrained bearings, and patients in their study had greater improvement in KSSs and functional scores.

Lee et al. [14] reported in their study that the revised UKA to TKA group had longer operation times resulting from additional procedures such as bone grafting and use of stems and augments, higher reoperation rates, and worse postoperative clinical outcomes based on the Western Ontario and McMaster Universities Osteoarthritis Index and OKS than the primary TKA group. We report a similar finding in our study that the revision of the UKA is technically more challenging than primary TKA. However, in our matched group study, the functional outcomes of revision UKA to TKA were more similar to a primary TKA [22], in terms of PROMs and overall proportion of satisfied patients.

When comparing patients who used stemmed implants, augments or constrained implants, there was no significant difference in outcomes between these groups at two-year follow-up. It has been reported that metal-backed tibia component UKAs had significantly better mid-term functional outcomes, more favorable biomechanics strain distribution and survivorship compared to all-polyethylene tibia component UKA [31–33]. However, metal-backed tibia components UKA had increased the chances of complex revision requiring stems and cruciate substitution during revision TKA [34]. In our study, a larger proportion of patients with metal-backed tibia components UKA required complex revisions requiring stems and cruciate substitution during revision TKA, but this proportion was not statistically significant.

This study is limited by being a retrospective review of an institutional registry, with a heterogeneous cohort. However, the preoperative demographics and their PROMs were well matched and similar for both groups of patients. Another limitation is that the duration of follow up was significantly longer in the primary TKA group compared with the UKA group with a range of follow up from two years up to 13.8 years, which may affect the comparison in longer-term re-revision rates.

In conclusion, this study showed similar outcomes following revision of failed UKA to TKA and primary TKA. There were significant improvements of overall PROMs for revision UKA to TKA, which is comparable to that of primary TKA, with a high proportion of patients being satisfied and having their expectations met by surgery. Patients should be counseled preoperatively about conversion of failed UKA to TKA, that despite the setting of more technical complexity, with the need for more extensive surgical exposure and more frequent use of revision components, this does not lead to any difference in PROMs at two years, earlier failure or increased complications in the longer-term follow-ups, which require re-revision. Metal-backed tibia components UKA did not significantly increase the risk of complex revisions requiring stems and cruciate substitution during revision TKA when compared to all-polyethylene tibia components UKA.

Conflict of interest

The authors have no conflicts of interest to declare.

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